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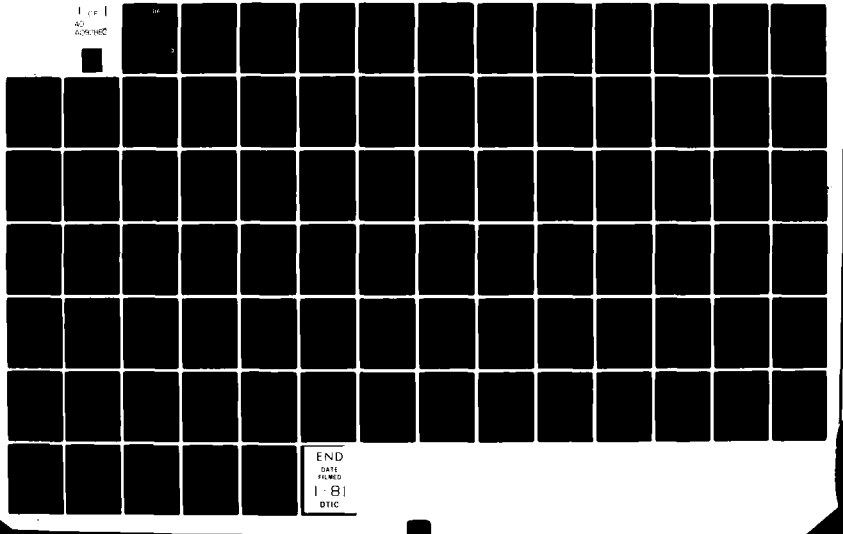

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Contributions to Industrial Development of Science and Technology Institutions in Malaysia and Opportunities for Bilateral Cooperation

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September 1979

Final Report to U.S. Department of State

The Program on Science, Technology, and Society
Cornell University
Ithaca, New York 14853

CONTRIBUTIONS TO INDUSTRIAL DEVELOPMENT OF SCIENCE AND TECHNOLOGY INSTITUTIONS IN MALAYSIA AND OPPORTUNITIES FOR BILATERAL COOPERATION

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PREFACE

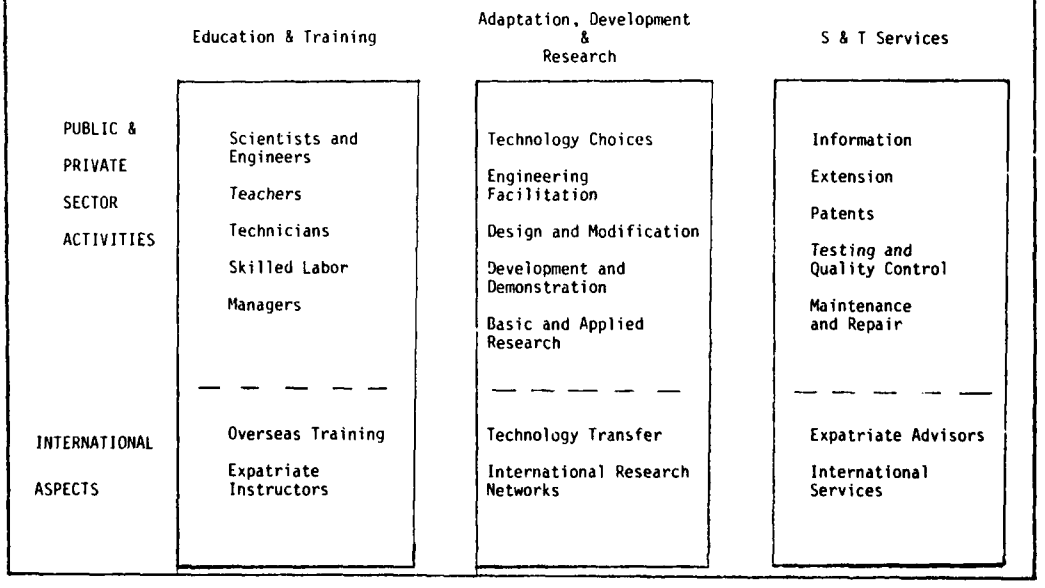
This report analyzes (a) the characteristics and capabilities of the principal institutions that comprise the science and technology infrastructure in Malaysia, (b) the potential contributions of these institutions to industrial development, and (c) opportunities for bilateral cooperation between these institutions and related institutions in the United States. Two companion reports analyze similar activities in Nigeria and Colombia. A fourth report presents a cross-country comparison of some of the principal findings in the three country reports. A final report describes the methodology used in carrying out the country studies.

The findings in the report are based largely on observations by a team of senior Cornell faculty members who visited Malaysia in January 1979. These observations were supplemented by documentation collected during and after the visit, principally from Malaysian sources.

Figure 1 identifies those types of science and technology endeavors that are considered in the report. Particular attention is given to the interactions among these activities and to the linkages between these activities and the efforts of production organizations.

Figure 1

FUNCTIONS OF THE SCIENCE AND TECHNOLOGY INFRASTRUCTURE



The emphasis is on science and technology activities which relate directly and indirectly to manufacturing; to the physical infrastructure needed to support industrial development including transportation, communication, power, and water systems; to development of the natural resource base; and to the education of science and technology professionals and skilled labor. Science and technology activities directed to medicine, public health, and nutrition are not considered. Similarly, the development and harvesting of food crops are beyond the scope of this study. However, the development and processing of non-food crops are considered to a limited degree.

Special appreciation is extended to the Ministry of Science, Technology, and Environment and many other Malaysian organizations which assisted in the collection of much of the data presented in the report and provided insights as to the problems and opportunities in the applications of science and technology in the country. Also, the assistance of the U.S. Embassy in Kuala Lumpur and the Department of State in facilitating the study and providing helpful suggestions is gratefully acknowledged.

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EXECUTIVE SUMMARY

The science and technology infrastructure of Malaysia is in an early stage of development. Very few Government laboratories or public educational institutions are currently in a position to be major factors in directly influencing the rate or direction of industrial development. For a number of years the Rubber Research Institute and the University of Malaya have been the most highly developed public institutions although even they are having increasing difficulty in retaining leading technical specialists and maintaining high quality standards. In the private sector, several engineering consulting firms which are somewhat dependent on expatriates and a few laboratories and training facilities of multinational corporations play important roles in industrial activities. Also, Chinese entrepreneurs have for many years replicated and adapted relatively unsophisticated foreign technologies to Malaysian conditions. Nevertheless, industrial development rests primarily on a base of imported foreign technologies and goods with very minor modifications.

Reflecting a commitment to an expansion of the nation's scientific and technical capabilities, the Government has recently established three bodies to improve approaches to research and education, namely: the Ministry of Science, Technology, and Environment; the National Council for Scientific Research and Development; and the Manpower Development Board. The Government has encouraged a private sector initiative to establish a National Science Foundation for increasing public understanding of science and eventually increasing the industrial contributions to research on national problems. Still, individual Government agencies set their priorities and establish programs on the basis of readily available technologies, and private sector activities are dictated by short term commercial interests with only minimal attention to the longer term payoff from research and innovation.

In the field of education, the matching of the supply of and the demand for scientists and engineers is a priority concern, with indications being that the supply is outpacing the demand. Complicating manpower planning is the lack of good information as to the projected requirements of industry and the activities and intentions of Malaysians studying abroad who comprise almost one-half of Malaysians attending universities. As the university system within Malaysia rapidly expands, there is a decline in the standards for admission and graduation, and steps are needed to minimize this erosion of academic achievement. There is a clear need for very careful nurturing of the development of a limited number of university graduate programs to insure their quality. The lack of coupling of vocational training activities with the interests and activities of private industry is striking. Finally, the national policy to increase the use of the Malay language throughout the educational system will undoubtedly cause difficulties as students without English preparation reach the university level where English textbooks of necessity will remain the backbone for science and engineering courses for the indefinite future.

The Government is expanding technical services available to small entrepreneurs. Several agencies, Government research institutes, and universities have outreach programs designed to provide advice and testing services for

small entrepreneurs in both the agricultural and industrial sectors. At the same time, the Government's approach to more broadly based information services is not well developed except in the rubber area. Scientists and students frequently lack access to technical information, and libraries and technical documentation centers are not adequate to serve the needs of the university or industrial communities.

The interactions among Government agencies, public educational and research institutions, and the private sector in science and technology are increasing but are still inhibited by a tradition of independent efforts. A number of interagency committees (e.g., environmental quality, energy, technology transfer) are helping to coordinate agency activities, and the chambers of commerce and trade associations are important in fostering information exchange within the private sector. The universities, with stronger support by both Government and industry, might play a more active role in providing a neutral meeting ground for private and public sector interests on a variety of technical issues. Also of importance are (a) a greater awareness by Government of the character and effectiveness of training activities of the private sector and (b) more deliberate efforts by Government to co-locate public sector research and educational activities at nearby locations and thereby encourage interactions among such activities.

The limited U.S. support of cooperative bilateral programs in science and technology has declined to an all-time low point at the very time when Malaysian institutions are reaching a level of development that offers interesting possibilities for cooperation. A principal need is for a funding mechanism that will enable U.S. senior scientists and engineers to make both short term (e.g., 1 - 3 months) and long term (e.g., 1 - 2 years) visits to Malaysian institutions which are developing and carrying out research and graduate education programs in their fields of expertise. Also, short term survey missions and seminars involving U.S. specialists in fields such as pollution control, computer sciences, and wood technology could be of mutual interest. Finally, collaborative research programs involving Malaysian universities, U.S. universities, and even U.S. multinational corporations offer attractive possibilities.

COUNTRY SETTING

Political

After achieving independence in 1957, Malaysia was organized as a parliamentary democracy operating as a constitutional monarchy. The Government has maintained political stability through the creation of the National Front (Barisan Nasional), a broadly based coalition of the United Malays' National Organization (UMNO), the Malaysian Chinese Association (MCA), the Malaysian Indian Congress (MIC), and a number of smaller parties such as the Penang-based Gerakan. The principal opposition parties are the Democratic Action Party (DAP) and the Pan-Malaysian Islamic Party (PAS).

The parliamentary system follows the British model rather closely. The lower house (Dewan Rakyat) of 155 seats is elected to terms of not more than five years. Elections were held in 1955, 1959, 1964, 1969, 1974, and 1978. About 60% of the constituencies are rural and therefore predominantly Malay; they traditionally form the backbone of electoral support for UMNO, the dominant party in the National Front. The ceremonial king serves as titular head of state and is elected from among the sultans of the Malay states every five years on a rotating basis. The Prime Minister heads the Government and is the de facto commander-in-chief of the armed forces. The civil service was inherited from the British and modeled after the Indian civil service.

Internal stability has been achieved in the face of recurrent political, social, and economic difficulties. While a long and bloody communist insurgency (1948 - 1960) withered in the wake of independence, its revitalized remnants based in southern Thailand remain a minor but expensive nuisance today. The creation of the Federation of Malaysia by the addition of Singapore and the Bornean state of Sabah and Sarawak in 1963 resulted in a short-lived confrontation with Indonesia. In 1965, Singapore separated from Malaysia and became an independent city-state. In 1969, racial violence in Kuala Lumpur in the aftermath of national elections resulted in a declaration of emergency rule. In 1971, parliamentary democracy was restored although constitutional restrictions were placed on public discussion of sensitive racial issues. In July 1978, the electorate returned the Barisan Nasional and its leader, Prime Minister Hussein Onn, with an overwhelming majority in Parliament.

Malaysia has taken a leading role in efforts to stabilize the political situation in Southeast Asia. Malaysia is an active member of the Association of Southeast Asian Nations (with Indonesia, Thailand, Singapore, and the Philippines), a group created primarily to foster economic cooperation among the five nations. The Malaysian Government has proposed the creation of a Zone of Peace, Freedom, and Neutrality in Southeast Asia. Malaysian officials have worked hard to develop an ASEAN consensus in support of the concept, and Malaysian diplomats have attempted to convince the major Asian communist powers, such as Vietnam and China, that they should back the idea.

Social-Cultural

There are three major racial groups: the Malays (50%), the Chinese (35%), and the Indians (10%). British colonial policy in the last century encouraged immigration of Chinese to work in the tin mines and Indians to work on the rubber plantations and railways. Separation of the races was promoted by both

policy and law. This separation was reinforced by religious differences. The Malays are almost exclusively Islamic. The Indians are primarily Hindu, although some are Islamic and Sikh. The Chinese embrace a variety of faiths, foremost of which is Buddhism. Intermarriage is uncommon.

While the British left the Malays to their traditional rural lifestyle, Indians came to dominate the professional ranks, especially law and medicine, and Chinese entrepreneurs operated virtually all commercial enterprises not controlled by British interests. A striking contrast still persists between the predominantly Chinese commercial sector in the modern urban centers and the overwhelmingly Malay smallholder agricultural sector in the villages (kampongs) of the rural areas.

The development of Malaysia's primary commodity-based economy during the past century spurred the pace of urbanization. Rural-urban migration, while a troublesome socio-economic phenomenon, is not as serious in Malaysia as it is in many other developing nations. However, the tendency for the Chinese to migrate to the urban centers has meant that they have often had much greater access to a variety of social services, especially health care and education, than have the Malays in rural areas.

The colonial heritage in education was a small, high quality school system designed by the British to train the personnel needed to manage the country. Quality primary education was available in the major urban areas. The very limited number of places at the secondary and tertiary levels were saturated with Chinese, Indians and, a very few upper-class Malays (most from royal families). Since independence, the Government has pursued a policy of universal education and has taken strong action to increase the entire population's access to education with special attention to the needs of the rural Malays.

The Government places the rate of population growth at 2.7%. Malaysia has a very young population. Fully 42% of its population is 0-14 years of age, while only 54.4% fall within the 15-64 year working-age group; the resultant dependency ratio is a high 84%. Thus, not surprisingly, education, especially upper secondary (the equivalent of U. S. high school), has become a major source of parental and pupil anxiety. A series of nationwide examinations based on the English system determine the promotion of students to upper secondary and tertiary level educational institutions. Competition for places in higher level educational institutions is intense.

Professionals are held in very high esteem in Malaysia. Malaysian parents in the modern sector want their children to become doctors, lawyers, and engineers. Lower social status attaches to work done with the hands, which includes not only manual but skilled labor as well. These values are most pronounced in the Malay community and are reinforced by pay scales which favor white collar personnel. Clerical workers frequently earn salaries equivalent to those of technicians and skilled laborers.

Major social, cultural, and economic differences exist between West Malaysia, or the Peninsula, and East Malaysia, which includes the states of Sabah and Sarawak. Although East Malaysia accounts for 60% of the nation's land

area and much of its natural resource wealth, it is home for only 16% of the country's population. East Malaysia's development lags far behind that of the Peninsula and is primarily confined to the coastal areas and the principal river ports. The indigenous peoples are not Malay but consist of an array of ethnic groups which include the Ibans and the Melanaus. Many members of these tribal groupings continue to cling to their traditional way of life based on communal longhouses, hunting, and slash and burn agriculture. The Government has assigned the development of East Malaysia top priority and is in the process of trying to expand both the physical infrastructure and the social services available to the region's inhabitants.

Economic

The Government is concerned about serious inequities in the distribution of wealth and income, with 38% of the population living below the poverty line. According to the 1970 census, 83% of the poverty households are Malay. Monthly average income figures for Chinese and Indian households were, respectively, 2.1 and 1.7 times greater than those for their Malay counterparts. The average incomes of urban households were more than twice those for rural households. While the top 10% of all households garnered nearly 40% of all income, the bottom 40% of the population had to settle for only about 12%. The states of Sabah and Sarawak are obviously the poorest and least developed. In Peninsular Malaysia, poverty is most concentrated in the five northern states of Perak, Kedah, Perlis, Kelantan, and Trengganu. The New Economic Policy (NEP) was specifically designed to redress these major economic imbalances.

The NEP is a comprehensive program for fundamentally restructuring Malaysian society. The NEP is designed to take advantage of the gradual transition which Malaysia has already begun to make from an agricultural to an industrial economy. The Policy's twin goals are the eradication of poverty and the elimination of the identification of economic function with race. The principal means by which this is to be accomplished is a broadly based set of social and economic programs to increase the participation of the Malays and the other indigenous peoples in Malaysia's economy.

One of these major programs seeks to greatly increase Malay ownership of shares of stock in publicly-held companies. Whereas in 1970 only 2.2% of all shares in such companies were owned by Malays, the Government has committed itself to a 1990 goal of 30% Malay ownership. Of this 30%, 7.4% will be owned by "Malay individuals", while the remaining 22.6% will be owned by a variety of "Malay interests", primarily government or quasi-government funds designed to hold the shares in trust until such time as they can be purchased by individual Malays and members of other indigenous ethnic groups.

The projected transformation of the Malaysian economy was designed to take place in the context of a rapidly expanding domestic economy led by the increased pace of industrialization. The NEP professes not to seek the physical redistribution of existing Chinese wealth for the benefit of the Malays. Rather, it seeks to apportion a greater percentage of an enlarged economy to the "indigenous peoples" while reducing the foreign ownership component and not adversely affecting the Chinese and Indian portions. With the exception of the 1974 worldwide recession, Malaysia has so far succeeded in achieving the macro-economic growth targets set out in the Second Malaysia

Plan (1971-1975) and the Third Malaysia Plan (1976-1980). GNP growth rates in real terms of 7% - 8% per annum have, on the average, prevailed during the 1971 - 1978 period.

Figure 2 provides some basic data on the Malaysian economy. Malaysia has a mixed economy with a heavy private sector emphasis. Many of the larger firms are controlled by multinational companies while many thousands of the smaller firms are owned by Chinese entrepreneurs who traditionally have provided much of the economic strength of the nation. Communications, utilities, some transportation (primarily the national airline, railways, and long distance bus service), and a few key activities such as oil exploitation are in the public sector. In addition, the Government owns significant amounts of share capital, though seldom a controlling interest, in a wide variety of private corporations.

Figure 2

ECONOMIC AND SOCIAL INDICATORS
(1978)

Population	12.9 million
Population growth rate	2.7%
GNP	$14.6 billion
GNP/Capita	$1132
Inflation Rate	5%
Manufacturing - %GDP	19%
Literacy Rate (as of 1973)	68%
Exports	$7.4 billion
% Export from Main Commodities	
Rubber	23%
Petroleum Products	13%
Palm Oil	12%
Tin	11%
Logs	10%
Sawn Timber	5%
Imports	$6.0 billion
Trade Surplus	$1.4 billion
% Import in Main Categories	
Machinery and Transportation Equipment	36%
Food	16%
Petroleum	10%

Source: Economic Report 1978/79, Ministry of Finance, Malaysia, p.6 and Statistical Appendix, pp.xiv-xv.

Nearly one-half the labor force is engaged in activities related to agriculture, especially in the production, processing, and export of natural rubber, palm oil, and timber products. Mining of tin, while decreasing in importance, remains a basic industry. Petroleum exports are projected to continue to increase for at least a few more years.

Perhaps of equal or greater significance for the future is the rapid growth of the manufacturing sector. Manufacturing now constitutes almost 20% of the Gross Domestic Product as compared with only 2% twenty years ago. Meanwhile, the construction industry has been the leading growth sector of the economy during the past several years. Construction of housing, commercial buildings, industrial facilities, and components of the transportation, communications, and electrical systems is transforming cities and suburbs and is now reaching out into rural areas as well.

Trade and Foreign Investment

During the last quarter-century, Malaysia has emphasized the exploitation of natural resources and has encouraged foreign and domestic investment in manufacturing and service activities. Exports of primary commodities enabled Malaysia to register favorable annual trade balances ranging from over $100 million to about $1.5 billion during the period 1973 - 1978. Figure 3 describes the character of U.S. trade with Malaysia. Consistently favorable trade balances since Independence have provided the financial resources needed to develop a good physical infrastructure for industrialization. In particular, the transportation and communications network which links the major towns and cities of Peninsular Malaysia has few parallels in the Third World.

Figure 3

U.S. - MALAYSIA TRADE
(1976)

U.S. Exports to Malaysia	$514,239,448
Machinery & Transport Equipment	63%
Chemicals	8%
Other Manufactured Goods	6%
Food, Beverage, & Tobacco	5%
U.S. Imports from Malaysia	$936,643,173
Tin	21%
Natural Rubber	18%
Palm Oil	13%
Petroleum	9%

Sources: U.S. Exports of Domestic Merchandise & U.S. Imports for Consumption 1976. U.S. International Trade Commission. Calendar year 1976.

Multinational corporations are a major force in the Malaysian economy. The five nations with the largest total investments in Malaysia at the end of 1977 were, in descending order, Japan, Singapore, the United States, the United Kingdom, and Hong Kong.

One hundred and sixty-two U.S. firms have investments in Malaysia. Of these, 52 are involved in manufacturing. An additional 11 are engaged in the extraction of primary products. Ten carry out engineering design, construction, and management consulting work. The remaining 89 firms are involved in a wide variety of service industries and marketing and distribution activities. By the end of 1977, total U.S. investment in Malaysia had exceeded the $1 billion mark. While far and away the major portion of this is in the petroleum industry, investments in the electronics industry and the banking sector are also substantial.

Malaysia's investment climate is generally perceived as favorable. The Government has succeeded in overcoming many of the initial problems related to the Petroleum Development Act of 1974 and the Industrial Coordination Act of 1975. Malaysia offers significant financial incentives to foreign investors. Furthermore, the dynamic Deputy Prime Minister, Mahatir bin Mohamed, also serves as Minister of Trade and Industry. He has spearheaded Government efforts to streamline the approval process for industrial projects and currently heads a major foreign investment recruitment drive directed at European, U.S., and Japanese firms.

MALAYSIAN DEVELOPMENT AND SCIENCE AND TECHNOLOGY INSTITUTIONS

The Role of Science and Technology

Further development of a science and technology capability is viewed by Malaysian leaders as one of the keys to the nation's future. While Malaysia is still in the early stages of becoming a developed industrial nation, its annual per capita income of more than $1,100 already places it among the wealthiest developing nations. Much of the increasingly well educated population aspires to a modern way of life far removed from the traditional smallholder agricultural sector, and wise utilization of the country's natural resources complemented by a strengthened manufacturing capability is to provide the opportunities for realization of these aspirations.

At the same time, the Malaysian Government believes that science and technology offer the potential for improving job opportunities and needed services for the rural population. Indeed, many of the imbalances in the distribution of income among the nation's racial groupings and between the several geographic regions are explicit targets of a variety of Government policies and programs related to scientific research, technological development, and manpower training.

The Government anticipates that Malaysia's industrial development will entail the evolution of many vertically integrated industries based on Malaysia's natural resources, particularly the renewable agricultural commodities such as rubber, palm oil, and timber. Over time, Malaysia should "wade downstream" from production of raw materials for export to increasingly sophisticated processing and manufacturing operations. The speed of this transition is directly dependent on the nation's capability to select, acquire, adapt, develop, and employ modern and appropriate technologies.

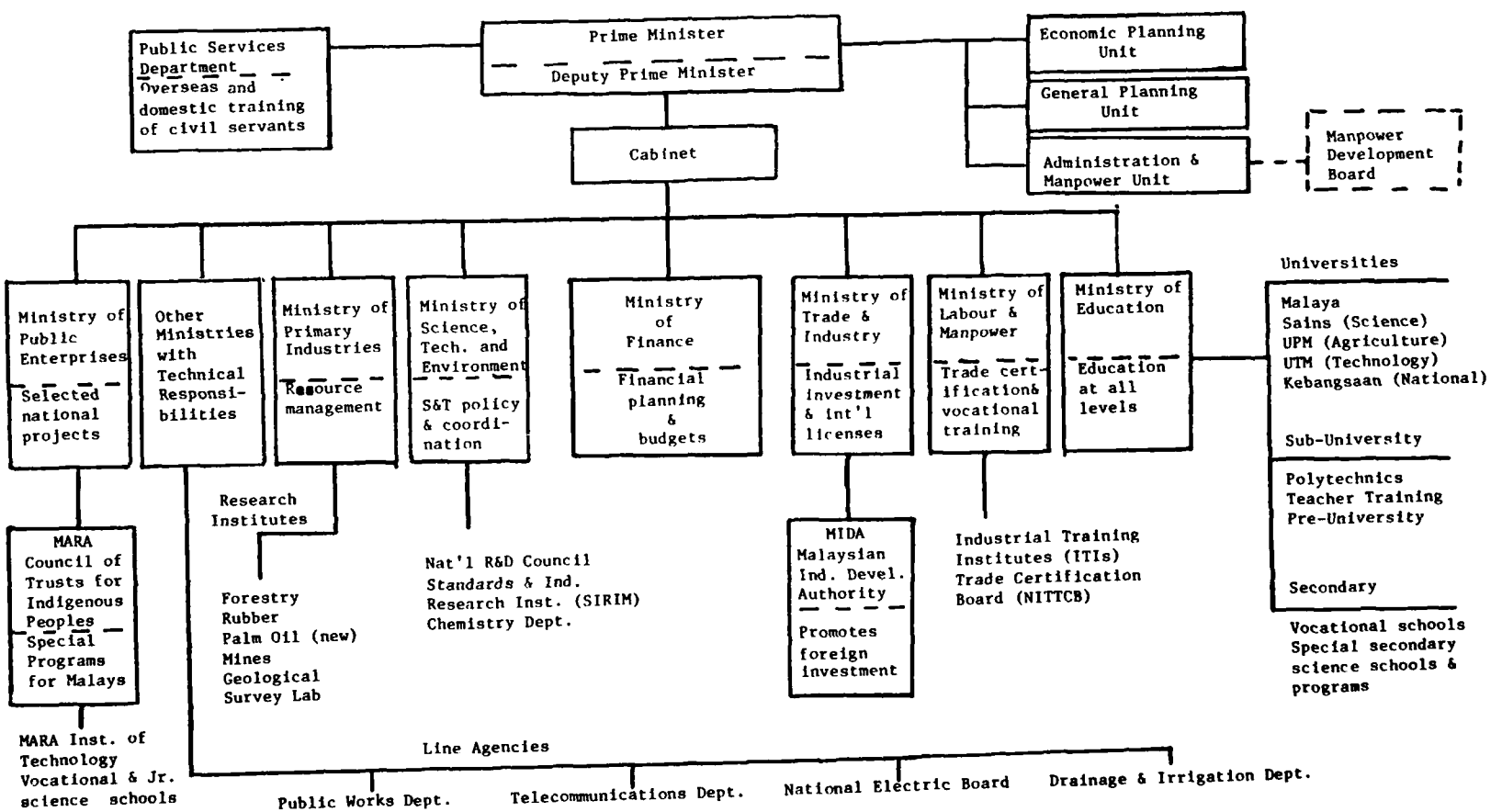
The principal elements of the current industrialization strategy are the micro-economic components of the Third Malaysian Plan's macro-economic conception of Malaysia's future. The Plan attempts to integrate the transition to a modern industrial society with the NEP goals of eradication of poverty and elimination of the identification of economic function with race. The Plan calls for an expansion of the science and technology base on which the manufacturing sector must rest as a necessary development for facilitating the shift to a modern society with economic and social benefits for all, and particularly the Malay segment of the population.

The Science and Technology Infrastructure

The core of an institutional base for a strengthened science and technology infrastructure is in place in Malaysia. As shown in Figure 4 , it includes a number of technical departments and institutions of Government agencies as well as a more limited variety of private sector activities. The public and private organizations are of varying quality, and they are in different stages of development. The strength of the existing infrastructure lies principally in (a) several high quality university science and engineering programs, (b) a few specialized training schools and vocational programs operated by Government line agencies and by private companies, (c) the Rubber Research Institute (RRI), (d) research and service departments of a number of multinational corporations, (e) a variety of public and

Figure 4

GOVERNMENT AGENCIES WITH MAJOR S&T RESPONSIBILITIES IN MALAYSIA

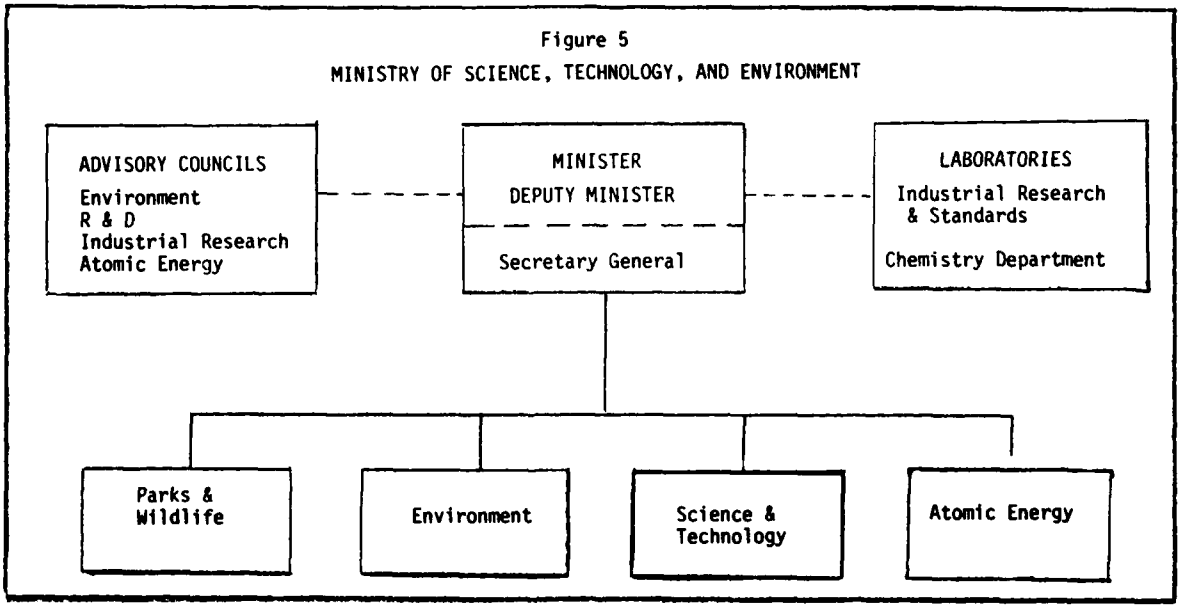


private sector testing facilities, (f) a handful of private consulting engineer firms staffed in part by expatriates, and (g) a number of reliable service and repair organizations operated by Chinese entrepreneurs.

At the policy level, the young Ministry of Science, Technology, and Environment described in Figure 5 and its National Council for Scientific Research and Development are only beginning to exert influence on Government policies and programs. Understaffed and still lacking in stature within the Government hierarchy, the Ministry nevertheless is gradually making its presence felt, relying largely on persuasion and a capability to assemble data about Government activities for its principal leverage. Preparation of the Country Paper for the 1979 UN Conference on Science and Technology for Development was an important responsibility that enabled the Ministry to begin to bring together many of the diverse interests throughout the Government in this field. Similarly, the "First Report of the National Council for Scientific Research and Development" provided a useful vehicle for inventorying the principal research activities of the Government and for making suggestions for improved approaches, particularly in the area of coordination. The Ministry has also spawned a coordinating committee in the field of environmental pollution and participates in other coordinating committees directed to energy and technology transfer. Still, most of the important Government activity in science and technology remains the responsibility of well established line agencies subject to periodic scrutiny by the Economic Planning Unit and the Ministry of Finance.

Figure 5

MINISTRY OF SCIENCE, TECHNOLOGY, AND ENVIRONMENT



Conspicuous gaps in the approach to science and technology include the absence of a coordinated effort to acquire and disseminate technical information in fields other than rubber, weak Government capabilities to assess the technical characteristics and implications of internationally available technologies, and the absence of effective linkages among many of the organizations and individuals engaged in related science and technology activities as discussed below. Also of concern is the decline in academic standards that has accompanied the rapid expansion of university science and engineering departments and the increasing tendency of technical agencies to take over technical responsibilities that in the past have been carried by highly qualified private sector organizations, such as the expanding design and construction activities of the Ministry of Public Works.

The University of Malaya, RRI, and other public institutions have made important contributions to the nation's technological development. However, much of the potential of the public educational, research, and service organizations has not been adequately developed or effectively exploited. In the education area, for example, there are no signs that the erosion of academic standards will be reversed. Thus, for the indefinite future Malaysia will -- and indeed should -- continue to rely heavily on overseas training at the university level. In another area, the Government research institutes are playing a very useful role in providing advisory, information, and testing services, particularly to small entrepreneurs. However, in view of their organizational separation from production activities and their difficulties in maintaining high quality technical staffs which are increasingly attracted by higher industrial salaries, they should not be expected to contribute significantly to the development of new industrial processes or products. The problem is largely the need for a better definition of the role of these institutes which is reflected in their program activities.

The private sector has good capabilities to acquire and use technologies developed throughout the world, and this capability is most vividly relfected in the construction activities in many parts of the country. However, the private sector's interest in significant research is low, and their development programs are limited largely to modifying products for the tropical environment, adapting product lines to respond to local consumer tastes, and seeking ways to use local materials more extensively.

The Importance of Improving Institutional Linkages

Stronger organizational linkages and improved collaboration at the working level among the many participants in science and technology activities could significantly increase the impact of the science and technology community on industrial development while reducing duplication of efforts and diffusing technological knowledge throughout the country. There are some examples of effective ties among insitutions and individuals; however, in general, the linkages are not well developed and in many important areas are almost nonexistent. Historically, Government ministries have had a strong tradition of autonomy and independent political backing. Now they are becoming increasingly sensitive over administrative jurisdiction. Meanwhile, some universities and research institutions have traditionally sought and maintained independence in the development and execution of programs and have frequently viewed outside influences as hindrances in achieving narrowly conceived goals. With regard to the private sector, a type of adversarial relationship seems to exist, whereby Government officials are reluctant to acknowledge the research and training contributions of private enterprise to national development. At

the same time, industry places little stock in the rationality of Government policies and the significance of Government research and technical service activities. Significant industrial representation is seldom included on Government coordinating committees. Indeed, the concept of private sector input into Government decision making has not been seriously considered.

Somewhat surprisingly, the interactions between the Government research institutes and the universities are quite limited. In some cases, such as at the Science University, institute research directors deliver occasional lectures and research workers are attached to university programs for short periods. Also, the Forest Research Institute, for example, provides opportunities for students from the Agricultural University to conduct research. However, such arrangements are not extensive. One problem inhibiting closer ties is the geographical separation of most of the institutes and the universities, and in establishing future educational and research programs, co-location of such activities should be encouraged whenever possible.

Even the interactions among research institutes needs attention. Recently, the responsibilities for exploiting rubber wood were sorted out among several institutes. However, poor communications still exist in some cases. For example, the laboratories of the Mining Institute and the Geological Survey are adjacent yet collaborative efforts are infrequent.

The universities and the research institutes can serve as important meeting grounds for the science and technology community to consider technical developments in specific areas. RRI has a long history of hosting national meetings, and the University of Malaya has been moving in this direction. Still, the reluctance of Government and industry to pool capabilities and knowledge is evident even in these rather well developed fora.

Progress is being made in the development of significant ties between the universities and industry, particularly as the competition among companies for Malay graduates intensifies. Similarly, industrial interest in Malay graduates of the polytechnical institutes and the vocational schools is stimulating a greater industrial interest in these public institutions. In the area of research, there are examples of industrial interest in university capabilities. For example, Exxon contracted with the Science University to conduct studies of the likely ecological impact of oil spills off the coast of East Malaysia. An environmental pollution control device developed at the University of Malaya has been purchased by industry. The Plastics Center at that University is trying hard to orient its activities to the needs of industry, and facilities at several universities are used by industry for routine testing.

Faculty members are seldom engaged as consultants for industry, partially as a result of regulations limiting consultant income for faculty members. On the other hand, the polytechnical institutes are short of staff and engage a number of instructors from industry on a part-time basis.

A significant development in bringing industry closer to public sector interests in research is the proposed industry-supported National Science Foundation, to be modeled after the Osaka Foundation. The first step is to be construction of a $10 million exhibition center for increasing public understanding of science, with later plans calling for the financing of research on problems of national importance.

EDUCATION AND TRAINING CAPABILITIES

Overview

An unprecedented expansion of education and training at all levels took place between 1970 and 1975 (Figure 6). Increases were particularly notable in secondary level vocational and technical training, sub-university level teacher training, and university education. The creation and expansion of a large number of educational institutions, including many with major scientific or technical training programs, enabled the Government to increase Malay participation in the educational system in a quantitative manner consistent with the goals of the NEP.

Figure 6

DEVELOPMENTS IN EDUCATIONAL SYSTEM

	Enrollment			Increase (%)	
	1970	1975	1980	1971-75	1976-80
Primary	1,682,187	1,897,138	2,209,040	12.8	16.4
Lower Secondary	420,644	649,706	812,122	54.4	25.0
Upper Secondary					
Arts & Sciences	92,928	167,053	277,774	80.6	57.7
Vocational & Technical	4,899	14,338	25,920	192.7	80.8
Post Secondary	11,532	17,988	39,908	56.0	116.3
Teacher Training	3,887	7,940	15,064	104.3	89.7
University					
Diploma Level[1]	4,993	16,827	25,578	237.0	52.0
Degree Level[2]	8,331	14,702	24,258	76.5	65.0
Total	2,229,401	2,785,742	3,428,663	25.0	23.1

1. Includes enrollments in pre-university, preliminary, and introductory course at the respective colleges.
2. Includes enrollments in preliminary and introductory courses being offered at the respective universities.

Source: Third Malaysia Plan 1976-1980, pp. 385-386. Condensed from Table 22-1.

The Third Malaysia Plan projected a second expansion in tertiary level educational enrollment from 31,529 in 1975 to 49,836 in 1980 (Figure 7). However, the speed of the 1970-75 expansion placed major strains on the educational system. Meanwhile, operating costs and cost projections for further expansion have risen considerably. As a result, it now appears that Malaysia has slowed the growth of at least some components of the educational system, most notably the universities.

Figure 7

TERTIARY EDUCATION ENROLLMENT

Universities	1970	1975	1977	(projected) 1980
University of Malaya	7,777	8,056	8,598	9,356
National University	169	2,562	3,860	6,241
University of Technology	692	2,263	2,898	5,125
Agricultural University	585	2,656	2,961	4,960
Science University	271	2,851	3,399	5,290
Ipoh Polytechnical	493	1,136		1,650
MARA Institute	2,142	7,872		9,215
Kuantan Polytechnical	-	-		969
Rahman College	1,195	5,133		7,030
TOTAL	13,324	31,529	21,716*	49,836

Sources: Third Malaysia Plan, 1976-1980, pp 387,394; Commonwealth Universities Yearbook, 1979, p. 1781

* Includes 1,224 part-time students.

Higher education activities are centered at five public universities and a large technical institute. At the next level, there are two polytechnical institutes, and a large "technical college" for pre-university and diploma studies. There are also 19 teacher training colleges.

At the secondary level, there are a large number of vocational schools and secondary schools operated by several different Government agencies -- and in several cases by private organizations -- that specialize in technical training. Also, a number of Government agencies and public corporations such as the Telecommunications Department, the National Electric Board,and the Malaysian Airline System operate their own training schools and programs for technical and maintenance staffs. Finally, there is also a major nationwide effort in progress designed to increase the science and mathematics content of school curricula beginning in Standard 1 (Grade 1).

Many of these institutions are new and are only now graduating their first students. Most are still recruiting and training a large number of their faculty members. Several are in the long and disruptive process of moving to new campuses and facilities. Thus, there is not a good basis for judging the caliber of their future performance. It is nevertheless clear that there is very considerable variation in the quality of the programs, the staffs, and the students among the various schools and universities.

Widespread expectations exist that many technical graduates, and particularly Malays, will assume managerial and administrative positions. For example, the faculty at the MARA Institute of Technology does not envision their students working as practicing technicians, at least not for any extended period of time. Even at the university level, it is anticipated that many diploma and degree graduates will eventually assume high paying positions as private sector managers and Government administrators. Such expectations inevitably influence course orientation and student performance requirements.

In addition to the formal educational system, there is also a substantial informal training system which is particularly critical to Malaysia's supply of engineers, technicians, tradesmen, and skilled laborers. Nearly all the subsidiaries of multinational companies provide training programs for Malaysian engineers and technicians. At least one major corporation operates its own technician-training school. Also, many large and small companies offer various types of on-the-job training and informal apprenticeships for craftsmen, mechanics, and skilled workers.

Manpower Planning

Malaysia, having embarked upon a major program for increasing its scientific and technical manpower base, has yet to develop usable projections for its future needs in this area. Such projections could provide useful guidance to Government agencies and academic institutions in establishing enrollment targets, to students in their career choices, and to the private sector in recruitment and training policies. It is extremely difficult to judge the current situation as to employment of scientists and engineers, let alone future requirements. Clearly, there is an unfilled demand at present for Malay university and vocational school graduates in almost all technical areas. On the other hand, many well-trained Chinese engineers are currently unemployed or underemployed.

Malaysia's last national comprehensive manpower forecast was completed in 1973. However, its methodology and projections have been seriously questioned, and many Government agencies, educational institutions, and private companies believe that improved manpower projections are essential. In recognition of these problems, the Malaysian Cabinet recently approved the formation of a Manpower Development Board under the Prime Minister's Department with jurisdiction over all classifications of manpower. Future manpower needs are to be analyzed by the Board, and applications for new, modified, or expanded training programs are to be reviewed by the Board. At the same time, there may be a problem of credibility in combining analytical and operational responsibilities in a single Governmental unit whose objectivity might be questioned.

Technical manpower requirements are particularly sensitive to worldwide economic conditions, synthetic substitutes for primary products, and inter-

national trade patterns. Smaller industries that are growing rapidly find it particularly difficult to estimate their future needs and fashion appropriate responses to controversial Government economic and employment policies.

Related to manpower planning is the difficulty in attracting trained personnel to rural areas. Two notable examples are the requirement for engineers and technicians to develop the Bintulu LNG project in East Malaysia and the need for science teachers in rural schools. A further complication arises from the tendency for engineers and technicians to abandon their technical specialities as soon as possible for better-paid administrative and managerial positions.

Undergraduate Education at Malaysian Universities

Many science and engineering faculty members received Ph.D.s abroad. Most of the remainder of the staff at or above the level of lecturer hold a variety of advanced degrees and certificates from foreign institutions. Most Assistant Lecturers and Tutors hold only the B.Sc. degree, and, in some cases, diplomas. Faculty members may have as much as 20-30 contact hours per week in classrooms and laboratories. The faculty members exhibit great dedication to university life, and those with advanced degrees, in particular, usually make some effort to keep abreast of developments in their fields abroad. Laboratory space and equipment range from barely acceptable at some institutions to excellent at other universities. Some facilities are newly occupied or under construction. Some libraries appear to be adequate for undergraduate education and very well utilized, with the vast majority of books and periodicals in English. However, faculty and students frequently lack access to technical information, and improvements in this area are needed.

Texts and reference materials are generally comparable to those used in U.S. universities. The better students are capable of dealing with this level of material, but is likely that adjustments must be made for those with less adequate secondary school preparation. Faculty at the better universities judged that their good students were capable of graduate work abroad. Many university science departments attempt to maintain high standards by the use of external examiners, including some from the United Kingdom. The command of English varies widely among students.

Employers are generally satisfied with the caliber of graduates from Malaysian universities. Academic standards for university graduates have slipped considerably from the earlier days when admission to the University of Malaya, as the nation's only university, represented true academic excellence. Private sector firms, particularly some of the larger corporations and engineering firms, feel that the graduates they hire from the University of Malaya (and to an increasing degree from the Science University) are as well prepared, and sometimes better motivated, than Malaysians trained abroad.

The University of Malaya has a well deserved regional reputation as a center of excellence at the undergraduate level. The Science University has made great strides in its first decade with the help of strong leadership, and it is rapidly establishing itself as a key element in Malaysia's science structure. The other universities understandably lag considerably behind in their development.

Figure 8

UNIVERSITY SCIENCE AND ENGINEERING BUDGETS

National University	Salaries	$2,671,364
	Other Expenses	317,273
	Total	2,988,537
University of Malaya	Salaries	3,898,855
	Other Expenses	286,014
	Total	4,184,869
Science University		
Geology	Salaries	379,548
	Other Expenses	46,714
Pharmacy	Salaries	400,085
	Other Expenses	40,059
Physics	Salaries	750,658
	Other Expenses	42,723
Chemistry	Salaries	907,760
	Other Expenses	81,659
Biological Sciences	Salaries	903,577
	Other Expenses	64,455
Applied Sciences	Salaries	59,820
	Other Expenses	6,818
	Total	3,177,018
Agricultural University		
Agriculture	Salaries	1,514,364
	Other Expenses	305,273
Forestry	Salaries	596,045
	Other Expenses	305,273
Agricultural Engineering	Salaries	556,591
	Other Expenses	197,727
Science and Environmental Studies	Salaries	1,582,318
	Other Expenses	713,636
	Total	5,704,186
University of Technology		
Civil Engineering	Salaries	536,364
	Other Expenses	65,000
Mechanical Engineering	Salaries	709,091
	Other Expenses	88,636
Electrical Engineering	Salaries	588,182
	Other Expenses	88,636
Center for Science Studies	Salaries	1,095,455
	Other Expenses	172,955
	Total	3,777,910
	Grand Total	$19,832,297

Source: Estimated Expenditures, 1979. Ministry of Finance. Extracted from individual university budgets.

Financial support for the university system is described in Figure 8 . The nearly $20 million (see Figure 9) allocated directly to university science departments represents 22% of the 1979 operating budget for the five universities, more than .5% of the 1978 Malaysian Federal Operating Budget, and more than .1% of the nation's 1978 GNP. In addition, a large portion of university capital budget funds is directed towards the construction of science facilities.

Figure 9

UNIVERSITY BUDGETS

	1978 Budget		1979 Budget	
	Operating	Capital	Operating	Capital
National University	$ 18,624,218	$ 22,495,620	$ 18,818,182	$ 21,272,727
University of Malaya	27,430,455	2,072,727	27,732,727	818,182
Science University	14,571,227	6,59 ,536	14,894,091	905,041
Agricultural University	15,036,636	9,238,636	17,254,545	8,565,551
University of Technology	12,129,773	11,418,636	10,746,818	10,784,550
MARA Institute	20,140,635	10,712,727	19,396,364	5,227,273
TOTAL	$107,932,944	$ 62,534,609	$108,842,727	$ 47,573,324

Source: Estimated Expenditures, 1979, Ministry of Finance, P.380

Political pressures have forced the universities to expand too rapidly in the absence of sufficient faculty and financial resources. The rate and direction of growth of the university system is clearly a central policy issue. The Government remains firmly committed to broader educational opportunities for the Malays while it tries to maintain academic standards. On the other hand, non-Malay dissatisfaction with Government higher education policies has forced the nation's leadership to consider expanding the number of domestic university places open to non-Malays. Hopefully, both concerns can be addressed without further compromising the quality of Malaysia's university system.

Another problem relates to the distinction between Degree and Diploma courses of study, which is reflected in both the curriculum and the admission standards for these two program classifications. Degree programs are designed to produce scientists, engineers, and school teachers. Diploma programs are designed for the training of advanced technicians and operation supervisors. In most cases, diploma students sit in different courses from their degree counterparts. One exception exists in those UTM departments, such as the Faculty of Built Environment, which offer an "integrated course" for the first three years. At that juncture, students are selected on the basis of merit to continue their studies for a degree; the remainder are simply awarded

their diplomas. Thus, it is not clear whether the Diploma is simply a secondary award or whether it truly reflects preparation of manpower for a special need.

Finally, there is continuing concern within the World Bank and other agencies as to the continued heavy enrollment in the liberal arts in preference to science and engineering. It seems clear that, if employment guidelines for hiring Malays are to be realized in the industrial sector, the current imbalance must be redressed.

Scholarship Support

A very large number of graduate and undergraduate university students attend school with the support of a variety of Government agencies. Scholarship students are overwhelmingly Malay. The agencies include MARA, the Ministry of Agriculture, PETRONAS (the National Oil Company), and the state Governments. For example, approximately one of every seven students at the University of Malaya holds a MARA scholarship. About 5,000 students overseas hold MARA scholarships, including about 1,200 in the United Kingdom and about 700 in the United States.

Scholarship students are bonded to work for the Government upon completion of their studies. The standard bonding period for undergraduates is seven years. For graduate students, a sliding scale is used which increases the bonding period as the number of years of scholarship support an individual receives increases. Parents or other relatives sign the bonds, which range as high as $70,000 for some students. In a limited number of cases, scholarship students are released from their bonds to take positions in the private sector.

Malaysia's bonding system has proven to be a very effective deterrent to the brain drain. At the same time, the job prospects in Malaysia for Malay technical graduates are so bright that most scholarship holders are eager to return.

Overseas Training

Nearly one-half of all Malaysian university and pre-university students attend institutions overseas (see Figure 10). The majority study in Commonwealth nations, although substantial numbers also attend European, Asian, and North American institutions. While many of the nation's best students choose to attend the University of Malaya, a significant number of Malaysians gain admission to, and often scholarships at, the very best overseas universities. A number of U.S. administered SAT scores fall in the 600s and 700s, despite the fact that English is a second or third language. Still, large numbers of Malaysian students, some on Government scholarships, attend a variety of low quality overseas institutions. In part, this reflects social, economic, and political realities; in part, it results from the inadequacy of the existing information system designed to familiarize students with educational opportunities abroad.

Figure 10

RELIANCE ON OVERSEAS TRAINING

Level	In Malaysia	Overseas
Degree	18,200	17,400
Diploma and Certificate	14,900	10,700
Pre-University (A-Levels and Preliminary Courses)	6,700	7,900
TOTAL	39,800	36,000

Source: Ministry of Education, January 1979 (Unofficial Figures)

The number of Malaysian graduate and undergraduate students at U.S. universities and colleges is growing, with 764 arriving in 1978 (see Figure 11). Most of these students are in the fields of science, engineering, business, and management. Of these new arrivals, 108 received scholarships and assistantships valued at more than $500,000. U.S. schools will probably continue to provide substantial financial support in the future. 429 of the new arrivals were sponsored by the Malaysian Government.

Figure 11

STUDENTS ARRIVING IN UNITED STATES IN 1978

764 at 217 universities and colleges

- -- Northern Illinois (55)
- -- LSU (37)
- -- Ohio University (30)
- -- Western Michigan (29)
- -- Southern Illinois (26)
- -- University of Wisconsin (19)
- -- California State at Chico (17)

Financial support

- -- Malaysian Government (429)
- -- Private (202)
- -- U. S. Schools (108 for $504,000)
- -- Other (24)

Area of Study

- -- 487 undergraduate/277 graduate
- -- 40% in science and engineering
- -- 30% in business and management
- -- 8% in agriculture
- -- 7% in education
- -- 15% in social sciences

Source: Malaysian-American Commission of Educational Exchange (Kuala Lumpur), 1978 Report (mimeographed form)

As this number of sponsored students increases and as fields of study become more specialized, selection of the most appropriate U.S. schools is of growing concern to the Malaysian Government. Also, as sponsored and unsponsored students return to Malaysia and assume positions of responsibility in increasing numbers, the nature of their U.S. experiences will impact on policies of interest to the United States in many areas. In view of the long-term importance to Malaysia and to U.S. interests of this major investment in training, consideration should be given to supplementing the general counseling service on U.S. educational opportunities currently provided by the Malaysian-American Commission on Educational Exchange, with a more specialized service in scientific and technical fields.

Graduate Education

The establishment of solid graduate programs in science and technology is a process which requires both time and major financial expenditures. Decisions as to staff and equipment are often irreversible and must be made with great care.

Embryonic programs exist at the University of Malaya, and modest expansion of graduate education efforts should be largely concentrated in this institution. Well-defined offerings in areas not covered at the University of Malaya will probably also be supported at the Science University and other universities. However, for some years to come, most Malaysians pursuing advanced degrees in the sciences and engineering will -- and should -- continue to attend institutions overseas.

The demand for scientists and engineers with advanced degrees will probably grow slowly. Industry, in particular, does not appear to have significant needs for graduates with advanced degrees. Corporations prefer to tailor advanced training programs to their own specifications. For many multinational companies, this includes training abroad. Furthermore, there are advantages to coupling undergraduate training in Malaysia with graduate training abroad. Sending students abroad is cheaper than developing quality graduate-level programs at home. The large number of foreign graduate programs provides the student with a broader range of program choices than could ever be hoped for in Malaysia. Study overseas exposes the student to new equipment and new technologies. Finally, the international experience broadens the individual's perspective on the world.

The University of Malaya has a strong and commendable interest in multidisciplinary graduate programs in fields such as environmental protection. In establishing such programs, care is needed to insure that they do not undercut the development of graduate programs along discipline lines which are also in the early stages of development.

Another type of "graduate education" takes place at the Government research institutes. After several years of employment, which is largely of a training character, many of the young scientists are hired away by the private sector or other Government organizations.

Technical-Vocational Training

In 1975 less than 8% of the upper secondary students (equivalent to Grades 10 and 11) were in the technical-vocational stream as opposed to arts and sciences. Concern over shortages of technicians and skilled workers and

over the multiplicity of related Government training programs was the driving force behind the establishment of the Manpower Development Board.

At present, several agencies (i.e., Ministry of Education; MARA; Ministry of Labour and Manpower; Ministry of Youth, Culture, and Sports) offer some form of technical-vocational training, primarily for the Malay population, in specialized high school level institutions. These programs are based on different, and indeed conflicting, philosophies and offer different curricula.

The Ministry of Education's two polytechnical institutes offer a 27 month course leading to a post-secondary Certificate. The Kuantan Politeknik that is housed in temporary quarters graduated its first class of 70 in January 1979. The Ungku Omar Politeknik at Ipoh gives every appearance of being a good training institution. It provides relatively broad-based technical training which should help make its graduates better supervisors and middle-level managers. The polytechnical graduates are well-liked by industry, although they are usually considered to be technicians rather than supervisors.

The Ministry of Education also operates 30 high school level vocational schools which are a part of Malaysia's regular secondary school system. The demand for space far exceeds capacity. These schools use the UNESCO approach to vocational training that emphasizes a rounded education, not merely the development of skills. Some 30% of the standard course of study is devoted to academic subjects. A significant number of the graduates from these schools are unable to find jobs.

One division of MARA operates nine vocational schools which offer a relatively intensive two-year training course in about 40 different trades. Established with ILO assistance, they reflect that agency's job-oriented approach to skill training. Places at the schools are also in high demand. It is estimated that about 75% of the graduates find jobs in the trades for which they were trained.

The Ministry of Labour and Manpower operates two Industrial Training Institutes (ITIs) and plans to open three more in 1933 with World Bank support. Many believe that these Institutes provide the best Government-sponsored vocational training in Malaysia. Industry is particularly pleased with the four-year work-study, apprenticeship training course for workers sponsored by individual corporations. The National Industrial Trade Training & Certification Board, which has some industry representation, has helped to maintain high standards at the ITIs.

Despite this proliferation of programs, no one is satisfied with the present system designed to train technicians and skilled laborers. Business and Government agree that technicians and skilled workers are not being produced in sufficient numbers. Some feel that the training is inadequate and often imbalanced, and most graduates require extensive supplementary training before they become effective workers in industrial settings.

The vocational schools have a number of major problems. First, most good students with alternative choices are not attracted to vocational education because white collar jobs pay the best salaries and have the highest social status. A second difficulty is that vocational schools are unable to

attract, train, and retain good instructors. The largest industries, especially the multinational firms, hire the better vocational school instructors. The vocational schools are no longer able to lure experienced people away from industry and, as a result, they operate in-house training programs for instructors, and even send some overseas for special courses. Finally, vocational students from rural communities are unable to find employment without moving to the cities. Despite Government efforts to disperse industry throughout the nation, industrial activity remains concentrated around the major cities.

Government agencies with large skilled labor and technician requirements have expanded their own training schools and programs. These programs tend to be very specific in nature with curricula tailored to particular technical needs of the agency. Some of these training programs have very fine facilities and equipment and competent teaching staffs. The agencies that operate them are satisfied with their overall effectiveness. These programs meet a critical need in the construction, telecommunications, electric power, and transportation (i.e., railways and airlines) fields.

Private Sector Training

Private corporations in Malaysia are involved in a wide range of training activities. Many of the larger corporations attempt to reduce recruiting uncertainties by offering university scholarships to students who have shown particular promise during secondary and pre-university studies. These scholarship holders are then provided with paid internship positions during university vacations. While most firms offer fewer than five scholarships per year, some offer as many as ten. The larger plantation companies have worked out an arrangement with the Government whereby the number of scholarships they offer is tied to their acreage in rubber and oil palm for the year.

At the technical-vocational level, a sizeable number of students are sponsored by businesses. Also, many corporations provide paid on-the-job training opportunities for diploma candidates and for vocational students. MARA operates a large on-the-job training program and reports that it is pleased with the cooperation from industry, especially from the multinational corporations.

The opportunity for students to work side-by-side with engineers, technicians, and skilled workers should become a more important feature of the Government's formal training system. These on-the-job opportunities have proven beneficial to the participating students, who are frequently rehired by the corporations who provide the training, and to the companies, which gain first-hand evaluations for such hiring decisions. Still, only a small portion of students have the opportunity to participate in such activities.

Private sector firms also operate their own in-house training programs. The corporate training schemes for engineers hired by multinational firms are very similar to those run by the parent companies and frequently include supplemental training overseas. Private companies are heavily involved in the training of technicians, skilled workers, and maintenance personnel. For example, Tractors Malaysia, Bhd., a subsidiary of the Malaysian multinational firm Sime Darby and holder of the Caterpillar equipment franchise, operates its own technical training school. Some Government vocational school instructors receive training at this school. Indeed, virtually all manufacturing

concerns, including the largest corporations and the smallest backyard family workshops, provide a spectrum of informal training and apprenticeship opportunities for their own employees.

Current Industrial Interests in Technology

For the foreseeable future, Malaysian industry will continue to rely heavily on importations and minor adaptations of technologies developed and used abroad. The heavy concentration of multinational corporations in the country intensifies this orientation. Such technological dependence is particularly characteristic of export-oriented manufacturing and assembly enterprises. For example, although not all electronics plants are particularly large, standardization and quality control requirements demand the use of industrial processes from abroad.

Similarly, major construction projects such as harbors, highrise buildings, and dams consistently depend on standard "western" design specifications. Of course, the very experienced engineering design firms in Malaysia attempt to maximize the use of domestically available materials. For example, reinforced concrete is used as a substitute for more expensive structural steel whenever possible. Also, designers generally assume that their structures will receive limited maintenance, and try to compensate accordingly.

Chinese entrepreneurs have played a major role in Asia in the replication of technologies for many years. The Chinese community in Malaysia has introduced, adapted, and maintained much of the technology that now characterizes small and medium industry in Malaysia. Their innovative work with spare parts for machinery has been a key element in the development of the maintenance and repair capacity which supports Malaysian industry.

The small and medium sized manufacturing sector in Malaysia is characterized by a very large number of firms, with many consisting of only one factory or workshop. They are often rather colorful, backyard, family operations -- hot, noisy, dusty, and full of hard work. They include such activities as small-scale foundries producing steel parts, machine tool shops, and sawmill operations. While some Malaysian officials view the technologies which these firms employ as unsophisticated and outdated, these seemingly intermediate technologies have proven to be commercially viable.

Many Chinese entrepreneurs are increasingly aware of the opportunities offered by modern technology. Many of the new generation of Chinese businessmen studied overseas, and they are beginning to adopt a wider variety of modern technologies. This orientation should result in a broader and more efficient industrial base. However, technology may not be the decisive factor in developing successful small and medium sized industry. Indeed, credit, land, and entrepreneurship are often the key constraints which determine the success and subsequent expansion of smaller business enterprises.

Another important industrial trend is the expansion of public sector enterprises, often with support from international development agencies. It appears that, in the near-term, such endeavors will be almost totally dependent on imported technologies.

Finally, overshadowing the modest technology development efforts in the manufacturing sector are the large expenditures by both Government and the multinational companies for research and exploration directed to the delineation and development of oil and gas deposits. While these efforts are based on well developed techniques of the industrialized countries, they nevertheless are adding a new dimension to science and technology activities within Malaysia.

Role of the Government in Technology Choices

The Government agencies are playing an increasing role in the choices of technology. More detailed procedures concerning licensing and investment, greater agency involvement in procurement activities, and the growth of public sector enterprises have significantly increased the Government's influence on the types of technologies that are introduced within the country.

Many Government agencies are involved in technology decisions. These include, for example, the procurement and construction activities of the Public Works Department, the Drainage and Irrigation Department, the National Electric Board, and the Telecommunications Department. MARA operates bus lines and sponsors small businesses. PETRONAS is the national oil company. PERNAS is a Government holding company which is involved in a wide variety of industrial enterprises. Their activities often require them to deal with domestic and international technical consultants and contractors.

The Ministry of Trade and Industry is responsible for the growth of the manufacturing sector and must approve all investment applications. Within the Ministry, the Industries Division and the Malaysian Industrial Development Authority (MIDA) are responsible for technology transfer. In dealing with applications for new and expanded industrial investments, the Ministry allocates investment incentives and prescribes the percentage of foreign equity ownership allowed for joint-venture enterprises.

The Investment Incentives Act of 1968 offers special encouragement to industries which are labor intensive, industries utilizing domestic raw materials, those providing further processing of the country's primary commodities, and industries which manufacture capital or intermediate goods, and those which are export oriented. Incentives are also offered for location of investments in designated priority development regions. The Action Committee on Incentives, headed by the chairman of MIDA, considers applications for industrial projects and makes recommendations concerning various tax incentives and the issuance of manufacturing licenses.

The Government controls the percentage of foreign ownership to prevent the displacement of domestic firms by foreign enterprises. Joint-venture manufacturing firms that produce only for the domestic market are now restricted to a very small foreign ownership allowance. However, for export firms, the majority of the equity may be foreign owned. In a very few cases, wholly-owned subsidiary privileges are granted.

The Ministry of Trade and Industry is responsible for approving licensing arrangements for technical collaboration, management assistance, and trademark utilization. The majority of these agreements are made between joint-venture subsidiaries and their home offices. Figure 12 presents some data

on licensing applications 1970-1977. Many of the criteria ostensibly used to jduge licensing applications are similar to those applied to industrial investments; for example, preference is given to labor-intensive processes and to technologies not yet in place in Malaysia.

Figure 12

INTERNATIONAL LICENSES

Type	Issued (70-77)	Pending	Cost
Technical Collaboration	274	144	1-5% of Sales
Management Support	47	15	Man-months plus Overhead
Trademarks	56	27	2% of Sales

Source: Industries Division, Ministry of Trade and Industry, January, 1979 (Unofficial Figures)

The Government's technical capability to assess the significance and implications of alternative technologies is not well developed. Part of the problem is organizational: available technical skills are not effectively used in the assessment process. Part of the problem is lack of experience in selecting, installing, and operating technological processes. Finally, political considerations often dominate the assessment process.

Neither the technical departments of the various ministries, agencies, and public corporations nor the staffs of the research institutes appear to have significant input into Government decisions on industrial investments by the private sector or on international licensing agreements. Only rarely does the Ministry of Trade and Industry consult with the research community on technical matters. While licensing and industrial investment decisions should be based primarily on socioeconomic priorities, many also require substantial technological input. The Ministry is aware of this need for increased technical input in its decision-making process and is actively involved in the new inter-ministerial Technology Transfer Council. The Ministry also hopes to utilize the technical resources of the National Council for Scientific Research and Development.

Adaptation and Research in the Private Sector

The research and development activities of Malaysian industry are quite limited, with most of the innovation activities carried out by multinational corporations. Few Malaysian small and medium sized firms have the financial resources, facilities, manpower, or inclination required to conduct research, although they are expert at adapting technology to local conditions.

The research and development carried out is limited largely to relatively minor alterations to adapt product ingredients to local conditions and accommodate consumer tastes. Most of these activities are located in Malaysia because the research must be carried out in the physical environment where the results will be used. Many entail field testing and adaptation of such products as paints, pesticides, and toothpaste. There have also been some limited efforts to make greater use of cheap local raw materials in such products as soaps and tires. A few corporations maintain their regional product testing facilities for Southeast Asia in Malaysia.

A very significant research center is operated by Guthrie. This facility breeds new varieties of rubber and oil palm clones, both for use by the company and for sale. Many of the researchers hold advanced degrees, and several were recruited from the Rubber Research Institute.

The Motorola laboratory in Penang offers another interesting exception to the general pattern of research in the country. At this laboratory, 15 highly skilled Chinese engineers are employed to design specialized circuitry in direct competition with the Motorola Research Center in Ft. Lauderdale, Florida.

Research activities in the private sector are likely to increase in Southeast Asia in response to expanding markets in the region. Some industrialists have suggested that tax or other financial incentives might marginally advance the timetables for the introduction of innovative activities by multinational corporations and might encourage the location of such activities in Malaysia in response to expanding markets in the region. However, other industrialists feel that limited financial incentives have little impact on the timing or activities of industrial facilities.

Government Research Institutes

The Government has concentrated its research efforts on the nation's natural resources. The Ministry of Primary Industries operates four research institutes related to the nation's principal primary commodities: rubber, forest products, tin, and palm oil. Also, the Geological Survey reports to the Ministry. A sixth institution, the Standards and Industrial Research Institute of Malaysia (SIRIM), is a semi-autonomous body under the Ministry of Science, Technology, and Environment.

These institutes are more accurately described as service rather than research institutes. They provide a range of essential technical services to Government agencies and to private enterprises, particularly small entrepreneurs. These technical activities include testing and analytical services, setting of product and safety standards, and extension-information services. RRI's role with regard to the development and dissemination of biological and harvesting technology, particularly for use by smallholders, is world renowned.

The Government research institutes have not enjoyed the same degree of success with regard to the development and promotion of processing and manufacturing technologies that they have had with their other activities. Even the Technology Center at RRI is a relatively new facility which is still in

the process of establishing effective ties with industry. There have been unrealistic expectations in the past that Government research laboratories could develop or even adapt processes for adoption by manufacturers in the private sector. Clearly, the most effective adaptations and innovations will be developed by technology groups which are directly linked to the enterprises which will use their technical outputs, be they in the public or private sectors.

For some fifty years, RRI has earned an international reputation for its efforts in the biological and harvesting aspects of rubber production. RRI is now attempting to develop a comprehensive, integrated approach to deal with all aspects of the Malaysian natural rubber industry. New activities include the Technology Center, a worldwide network of user-oriented regional offices, increased emphasis on applications technology, and more sophisticated economic policy analyses. The Malaysian Rubber Research Development Board, which oversees RRI, also maintains a significant research and development capability at the Tun Abdul Razak Laboratory in Brickendonbury, England. This laboratory, dedicated primarily to applications research, is in close contact with potential markets in developed countries.

All of the research institutes have a major problem retaining experienced scientific personnel. All have unfilled positions, and none have effective recruiting programs that anticipate staff turnover. At present, they experience annual losses of 10-30% of their professional staff to the private sector. As previously noted, the research institutes fulfill an advanced training function in the absence of domestic graduate-level education. However, this continuous drain of the most qualified and experienced personnel has a debilitating effect on the laboratories. Continuity of projects, maintenance of equipment, establishment of national and international contacts in academia and in industry, program planning -- all normal functions of a viable research institution -- suffer from this instability. This situation is not likely to improve in the foreseeable future.

Program funding at SIRIM and RRI appears to match their current capabilities. There may be an increase of the "cess", or export tax, on natural rubber to support additional rubber research. The level of effort at the Forest Research Institute is not adequate in view of the importance of the timber industry to the Malaysian economy and the serious forest resource management problems the country faces. If meaningful forest management programs are not developed and introduced, it is likely that many timber resources, especially easily accessible lowland hardwoods, will be exhausted in little more than a decade.

University Research

An integral part of the development of graduate education programs must be the strengthening of research capabilities at the universities. Further, expanded research activities are important in retaining the scientific skills and dedication of highly trained faculty members.

The rapid expansion of university enrollment in the early 1970s resulted in an acute shortage of trained faculty and has required staff members to devote the vast majority of their time to undergraduate teaching. Also, many university laboratory facilities have either recently been completed or are still in the construction and even design stages. Thus, there are limited research efforts at the universities and only a few examples of engineering and scientific research programs which have been of interest to industry. The Plastics Center at the University of Malaya, while small, is one example of

an activity fairly well oriented to industry. In the geological and agricultural sciences, there have been some opportunities for faculty and students to carry out field investigations of interest to Government research institutions. However, university research is neither well developed nor very well coupled to the main interests of Government and industry.

Multidisciplinary research directed towards problems of particular importance to national development can be a significant part of graduate science programs. Individual staff members at the University of Malaya have demonstrated their capacity to make contributions in fields such as environmental analysis, development planning, and analysis of social problems. However, large-scale multidisciplinary research programs, such as those being planned for the University of Malaya's Graduate Research Center, are still in their conceptual stage.

As laboratories are completed, graduate-level programs are expanded, and the shortage of teaching faculty eases, research activities at Malaysian universities will most certainly increase. However, the quality, sophistication, and relevance of university research could be enhanced if current restrictions on consulting income for professors were relaxed. Also, a more extensive Governmental program of research grants to universities will be needed.

SCIENCE AND TECHNOLOGY SERVICES

Information Services

Malaysia does not have a coordinated national approach to the acquisition, storage, and dissemination of technical information. Individual agencies and public institutions have traditionally serviced their own needs. Large companies in the private sector have relied principally on business contacts for obtaining needed documentation. Smaller entrepreneurs have increasingly become targets for information disseminated through extension agencies.

The libraries at about a dozen Malaysian research and educational institutions house a large proportion of the nation's scientific and technical information. These university and research institute libraries are particularly critical because they receive a number of foreign journals, especially from the United Kingdom, which help keep Malaysian scientists informed about technological developments abroad. RRI's collection is perhaps the largest single holding of written materials on natural rubber in the world. The personal collections of the various faculty and staff members at these institutions are yet another valuable resource; some faculty members have their own subscriptions to journals which are of particular interest or relevance to their work. However, certain types of technical information, such as special issue publications and foreign journals from non-Commonwealth countries, are not available.

The publication of scientific and technical information within Malaysia is still very limited. There are a few scientific and technical journals published by the universities and research institutes. The Rubber Research Institute has the largest budget for publication and distributes a number of its written products on a worldwide basis. Other scientific monographs and reports published are, in general, quite limited, and at least some institutions experience serious publication backlogs.

A number of technical publications are printed by the Government Printing Office. Scientific institutions also utilize the private printing companies in Kuala Lumpur for their journals, reports, and brochures. These firms are capable of printing a high-caliber product. However, limited domestic demand represents a seemingly insurmountable constraint on the growth of Malaysia's technical publications industry.

An important, and often overlooked, information dissemination mechanism is lodged in the activities of the professional societies and trade associations. Indeed, they probably represent a seriously under-utilized mechanism for bringing available technical information closer to the users and for facilitating technology diffusion within the country.

There is widespread dissatisfaction in the nation's scientific and educational communities with the lack of support received from the Dewan Bahasa dan Pustaka, an agency which serves as the National Language Center. Malay is now the principal medium of instruction in the primary and secondary school system, and is to become the medium of instruction in the universities, particularly for introductory courses. All university final examinations must be written in Malay. However, as yet, the universities have received little assistance from the Language Center in the transition from English to Malay.

Extension Service

The research institutes and a number of Government agencies provide extension advice to smallholders and plantation producers of agricultural commodities, to small mining concerns, and to small-scale business enterprises.

RRI's success has been based to a large extent on the mass promotion and dissemination of technological developments, particularly its high-yielding clones. RRI's Advisory Services Division and researchers have worked in close conjunction with staffs and extension services of RISDA (Rubber Industry Smallholders Development Authority), FELCRA (Federal Land Consolidation and Rehabilitation Authority), and FELDA (Federal Land Development Authority). By 1978, this joint effort meant that about 90% of the estate acreage and about 70% of the smallholder acreage had been replanted with new high-yield varieties.

The Mines Research Institute provides limited technical assistance to small mining concerns with particular emphasis on enabling these companies to comply with Federal mine safety regulations. SIRIM does extension work with small industry. They assist some firms with the implementation and refinement of industrial processes. They also provide firms with technical advice on quality control measures which will enable them to have SIRIM's "mark" (i.e., seal of approval) attached to their products.

The impact of these efforts on the manufacturing sector is difficult to judge. Technical capability is but one aspect of viable commercial endeavors. These activities will undoubtedly continue in the future, and a better understanding of the payoff is needed.

Testing Services

The Government research institutes and laboratories provide essential testing services for government agencies and small businesses, usually charging users very nominal fees for these services. In addition, there are a sizeable number of private testing and analysis labs (at least a dozen in the Kuala Lumpur vicinity) which operate on a commercial basis.

The Chemistry Department and the Geological Survey provide forensic chemistry services for the Police Department and carry out analyses for the Customs Department. The Mines Research Institute and the Geological Survey analyze core samples and provide mining firms with technical information on which to base investment decisions. The Forest Research Institute does testing for potential suppliers and customers of Malaysian timber products. These examples represent a sampling of the variety of available testing services. At least two institutions also establish standards and quality control regulations. SIRIM, as the standards institute, sets the specifications which firms desiring to obtain the SIRIM seal of approval must meet. Likewise, RRI's Specifications and Quality Control Division establishes and enforces the grading schedule for the various classifications of Standard Malaysian Rubber.

The principal problem with Government testing is slow service. The low fees have placed these services in high demand. The Chemistry Department is in the process of doubling the size of its largest facility. The RRI experience with Standard Malaysian Rubber suggests at least a partial solution to the problem of backlogs. RRI has licensed about 30 private laboratories to do the analyses required to assign the appropriate grading designation to the various classes of natural rubber which bear the SMR seal. Other research institutes could license private labs for other kinds of analyses. Initially, perhaps some of the 30 laboratories would be interested in expanding their operations into these other areas.

OPPORTUNITIES FOR BILATERAL COOPERATION

Background

Malaysia has a long tradition of sending students abroad and utilizing foreign advisors and teachers. In recent years, the number of students abroad has risen sharply, while the number of expatriates in Government positions has greatly declined.

At present, there are a number of international and bilateral aid programs operating in Malaysia, and a variety of other regional and bilateral programs exist which involve Malaysian institutions with foreign Governments and private organizations. The World Bank and the various UN agencies, in particular, have provided significant financial and technical assistance to Malaysia since Independence, and their imprint on the scientific and technical education institutions is strong.

Despite the absence of a bilateral AID program in Malaysia, several effective U.S. mechanisms for fostering a modest level of collaboration in science and technology have operated in Malaysia in recent years. Figure 13 identifies a number of these programs. Ironically, at the very time that Malaysian science and technology activities are reaching the stage of development which offers many more opportunities for mutually beneficial collaboration, these mechanisms are disappearing. The Ford Foundation, the Fulbright Program, and the East-West Center have virtually terminated support for science and technology programs in Malaysia. The Asia Foundation no longer gives science and technology high priority (beyond providing elementary school textbooks). The program of the International Executive Service Corps is essentially dormant in Malaysia, although a revival may be in the offing. The Peace Corps, which has operated extensively in the areas of higher education and scientific research in Malaysia, is reorienting its programs under the "basic human needs" philosophy. Its future participation in science and technology activities will be limited to providing teachers for high school science and mathematics, and even these activities are to be supported at a reduced level.

Figure 13

SELECTED COOPERATIVE PROGRAMS

Peace Corps: 120 science, math, and vocational teachers

Asia Foundation: Travel grants for Malaysians in many fields; science books

Fulbright and East-West Center: Occasional scientist exchanges

International Executive Service Corps: Minimum activity

Ohio University: Off-campus degree program

Louisiana State University: Training of students for Agricultural University

U.S. Agency Programs: Training in nuclear research, LANDSAT, monsoon research

MITRE Corporation: Occasional seminars

This backdrop of international experiences - experiences in which the United States has not been a major participant - undoubtedly influences Malaysian attitudes towards specific types of cooperative programs. The limited U.S. Government involvement in the past may be an advantage in shaping the style and substance of programs that will be most appropriate during the coming decade.

The scientists and engineers within the country are increasingly confident of their capacity to provide a greater portion of the nation's technological needs. They are eager to address tough problems and to make the most of opportunities for interaction with their colleagues from overseas, particularly those from the United States, which they acknowledge as the world's leader in science and technology. Thus, there will be new opportunities for experienced Americans to provide advice on specific technical issues, to critique Malaysian approaches, and to evaluate the appropriateness of large investments of manpower and financial resources in areas of technical uncertainty to the Malaysians.

In general, the Malaysian Government favors collaboration in areas where Malaysia already has a degree of expertise, and the U.S. contribution would be in the form of a further strengthening of this capability. From the U.S. perspective, this approach is attractive since American participants should find collaboration with Malaysians who already have some expertise more rewarding than working in areas which are essentially new fields in Malaysia. Research and technical areas of priority interest to Malaysia which are also fields of U.S. technical strength include forestry management and timber utilization, watershed management, soil erosion and conservation, pollution control, park and wildlife management, geological mapping and geophysical techniques, minerals development, product standards and specifications, chemical analysis techniques, and the engineering sciences.

Some areas of potential research in Malaysia that would be of lower priority to Malaysian institutions might be of considerable interest to U.S. scientists (i.e., botany, zoology, taxonomy). In the past, arrangements have been made to carry out studies of marginal local interest, often through the Peace Corps. Occasionally, these researchers have taught courses at Malaysian universities in exchange for local logistical support. While such arrangements will probably be the exception, they could prove beneficial to both the Malaysian universities and the U.S. scientific community.

Cooperation with Malaysian Universities and Research Institutes

The existing linkages between U.S. and Malaysian universities are related primarily to undergraduate studies. Large numbers of Malaysians traditionally enroll in several U.S. universities, and Malaysia is interested in establishing annual "quotas" at these and other U.S. schools in order to ease admission uncertainties. Over the years, visiting faculty members from many U.S. institutions have taught at the undergraduate level for one or two years in Malaysia, and some of them have retained personal contacts through return visits and through Malaysian students. Ohio University has an off-campus degree program at the MARA Institute of Technology where Ohio University degrees are awarded in Business Administration for work done exclusively in Malaysia. This type of arrangement will probably expand as other U.S. schools seek ways to offset the decline in enrollment of U.S. students.

As another example, Louisiana State University (LSU) has played a major role in the development of the National Agricultural University. Many faculty members and Government employees have completed degree work at LSU. Malaysia has been prepared to finance cooperative arrangements designed to provide relatively standard undergraduate training, and additional funding mechanisms do not seem necessary for such activities.

As Malaysia develops its capabilities in graduate education and research, opportunities for increased cooperation between U.S. and Malaysian universities will emerge. However, if cooperation is to develop, new funding mechanisms will be needed. It should not be difficult to interest some U.S. university departments and professors on sabbaticals in the opportunities in Malaysia, particularly in the geosciences and biosciences. Annual funding to support several long-term U.S. specialists (i.e., 1 - 2 years) at Malaysian universities could be very helpful, particularly in the more specialized scientific areas where a local capability is only beginning to emerge. Such visitors could also reinforce undergraduate programs as well as help develop more advanced programs. A second funding need is for a program of small research grants to the local universities which would focus currently latent research capability on specific problems and also provide a local capability for collaborative activities in interesting areas. Finally, funds are needed if joint research programs of a sustained character between U.S. and Malaysian institutions are to be seriously considered.

In many ways the Government research institutes provide a better base in Malaysia than the universities for cooperative applied research activities. Most of these institutes are accustomed to working with foreign specialists and have experience in developing programs that benefit both parties. Several types of arrangements would probably be of interest to these institutes, namely: (a) joint research projects involving work in both the United States and Malaysia that would culminate in jointly authored reports (e.g., use of LANDSAT imagery, determination of wood properties); (b) long term visits by recently retired U.S. experts, including retirees from Government and universities (e.g., forestry, geology, watershed management), and (c) visits by senior U.S. scientists spending several weeks per year for several years in Malaysia reviewing specific research activities in their areas of expertise. The funding requirements are similar to those needed for university-to-university programs.

These suggestions are closely linked to the purposes of the Institute for Scientific and Technological Cooperation. While the specific programs need to be defined jointly with the Malaysians, it seems clear that there would be technical benefits to Malaysia from involvement of the appropriate U.S. institutions and individuals in many technical fields. Since the technical benefits to U.S. participants will be substantially fewer, much of the problem will be in gaining a genuine commitment from the U.S. participants and in designing mutually attractive programs.

Regional Programs

Several new international research programs with a regional focus are slated to be headquartered in Malaysia, including programs in tin research, environmental science, and geological dating. These programs are in fields of considerable importance. At present, however, there is little basis on which to judge the likelihood that these efforts will succeed. The financial commitments are modest, the quality of their technical leadership and staffs is unknown, and the character of the research efforts is uncertain. The pro-

gram of geological dating of rock samples from the ASEAN region at a central facility in Ipoh, using sophisticated analytical equipment obtained from the Swiss Government, seems straightforward. However, the viability of the approaches in tin research and the environmental sciences is less certain. These facilities are to be staffed by scientists made available by the participating Southeast Asian Governments and some additional UN advisors. As these programs develop, the appropriateness of U.S. participation should be considered.

Another type of regional program that might be explored is a training center for vocational school instructors that is closely coupled to industrial activities in the area If such a facility is appropriate, U.S. involvement would seem important.

Involvement of the Private Sector

A variety of Malaysian professional associations, trade organizations, and other private sector institutions probably could serve as Malaysian counterpart organizations in collaborative programs that would impact on both public and private sector activities. For example, the Institute of Engineers, the Institute of Chemists, the Federation of Malaysian Manufacturers, and the Malaysian Institute of Management are frequently involved in informational and educational endeavors. These, or similar organizations, might be appropriate focal points for seminars or joint studies involving industrialists and technical staff in areas that are rapidly evolving, such as pollution control and computer technology.

More imaginative approaches are needed to encourage the multinational companies to give attention to opportunities for innovation in Malaysia and to expand their outreach activities to the local science and technology community. The recent interest of Weyerhauser in reforestation is an example of this type of effort. The U.S. Government, through the support of studies and seminars directed to this area, could play a useful catalytic role.

U.S. Agency Programs

The U.S. Government is not well informed as to science and technology activities in Malaysia nor sensitive to the opportunities for productive bilateral interaction in this field. Indeed, there is little awareness of some of the existing programs funded directly or indirectly by U.S. agencies. To help remedy this situation, and particularly in view of the likely expansion of UNDP programs and U.S. programs through ISTC in Malaysia, consideration should be given to assigning a Regional Scientific Attache in Southeast Asia whose area of responsibility would include Malaysia.

The International Communications Agency should be commended for its student advisory services in Malaysia and for its awareness of developments in the Malaysian university system. In addition to further strengthening the advisory service as previously suggested, the Agency might consider expanding its information activities in science and technology. Specifically, expansion of its school textbook program and initiation of other programs to disseminate information on science and technology developments in the United States appear warranted.

The Peace Corps should reconsider its decision to cut back its high-school level teacher program. This program is effectively responding to a priority Malaysian need.

APPENDIX A

University of Malaya

Location: Pantai Valley, Kuala Lumpur 22-11

Vice-Chancellor: Ungku Aziz

Founded: Kuala Lumpur Campus established in 1959--offshoot of University of Malaya-Singapore (established 1949)

Enrollment: 1977--8600

University Facilities:

Library: 609,000 volumes. 8700 periodical subscriptions.

Hostels: Capacity--3500

ENGINEERING:

Graduates/Year: 200 (Up from 100 in 1970)

Faculty: 55 of 71 staff positions occupied. Virtually all Ph.D.'s who received their graduate training abroad.

Facilities: University support described as "generous." M $1.5 million (US $700,000) stock endowment for instrumentation purchase.

Admission: Very competitive. Accept 1 of 10 applicants. Engineering among most popular professions.

Curriculum: Four-year course after HSC. Cooperative/Work Study: 3 months in industry after Year 1; 5 months after Year 3. Departments: Chemical, Civil, Mechanical, Electrical. Civil most popular discipline. Limited to 80 civil engineers/graduating class.

Employment: About 50% begin careers in Government to fulfill service requirement of Government scholarships. Many switch to private sector after 7-year bonding period. Salary and promotion prospects better with private firms. Public Works Department usually hires 50-60 graduates/year. Significant numbers also recruited by Telecommunications Department and National Electric Board

Remaining 50% find jobs in private sector. Civil graduates prefer private consultancy and engineering firms. Mechanical, Electrical, and Chemical graduates take variety of positions in industry.

Employer Satisfaction: Engineers from University of Malaya widely perceived as best-trained science graduate educated domestically and competitive with Malaysians trained abroad.

CHEMISTRY

Graduates/Year: 150

Graduate Students: A few part-time Ph.D. candidates from Government research institutes, namely MARDI and RRI.

Faculty: 37 faculty (43 positions) with graduate training abroad. Nearly all are Ph.D.'s.

Facilities: Well designed laboratories. Air-conditioned with reasonably good equipment.

Admission: Competitive. About 1 in 3 applicants accepted.

Curriculum: Two 4-year courses of study offered. B.Sc. and B.Sc. with Education. Honors classification awarded on basis of merit. Department very conscious of nation's interest in applied work. Curriculum and research efforts structured accordingly.

Employment: 75% of Department's graduates enter secondary school teaching. Moderate number choose industry and research activities of federal government. Faculty members anticipate more students will enter industry in future.

Employer Satisfaction: Chemists also in high demand, in part because of pressing need for secondary school teachers.

Other Activities: Although members of Department's faculty do little consulting work, they perform a number of tests on the University's special equipment for private industry. Staff remunerated for this activity, but, as with consulting, there are ceilings on the total amount of income that can be earned.

PHYSICS

Graduates/Year: 130 - 50 B.Sc. Honors and 80 B.Sc.

Graduate Students: 4 Ph.D. and 4 M.Sc. candidates enrolled.

Faculty: 26 faculty members.

Facilities: Laboratories adequate for teaching purposes although some equipment not up-to-date.

Admission: Competitive. While not on par with Engineering, faculty members still judged student caliber as quite high.

Ethnic Composition: Department actively recruiting Malay students. Whereas only 5% of enrollment was Malay few years ago, today about 25% of Physics students are Malay.

Curriculum: 4-year course leads to B.Sc. Honors. 3-year course leads to standard B.Sc., holders referred to as "pass graduates." Curriculum consciously oriented towards applied physics.

Employment: 50% secondary teaching. 15-20% private sector 10-15% M.Sc. and Ph.D. programs abroad. Very few to Government research labs.

Employer Satisfaction: Graduates fairly attractive to industry, and some MNCs would be pleased to have more physicists.

RESEARCH: Of all Malaysia's universities, University of Malaya has greatest near-term potential for pursuing significant scientific research. A small Plastics Center already exists which is fairly well-coupled to industry. However, at present, teaching loads, restrictions on consulting income, absence of graduate programs, and funding limit amount of scientific research at the University. While these limitations insure that undergraduate teaching (the institution's and the nation's top priority) is not neglected, they simuntaneously reduce incentives to do research. As a result, growth of University's research capability may be stunted.

See Also: University of Malaya Calendar: Academic Year 1978-79

University of Malaya: Chemistry Department, 24 page pamphlet.

Departmental mimeos on Bachelor of Engineering Curriculum.

Commonwealth Universities Yearbook 1979

Universiti Sains Malaysia (USM)
(University of Science Malaysia)

Location: Minden, Penang

Vice-Chancellor: Tan Sri Datuk Haji Hamdan Sheikh Tahir

Founded: 1969

Enrollment: Total 1977-78--3,399
Full-time 2,561
Off-campus 838

Science Enrollment--includes Mathematics; Housing, Building and Planning; other science-related programs--Total 1748: Undergraduate 1693; Graduate 55.

University Facilities:

Library: 200,000 volumes. 5000 periodicals.
Annual intake: 25,000 - 30,000 volumes

Hostels: About 1670 places.

Curriculum: Off-campus program. 4 years home study of syllabus and lecture synopses. 3-4 weeks in residence yearly. 5th year spent in residence on USM campus. Standard degree programs--4 years in length. B.Sc. with Education candidates take teacher training courses at nearby Malayan Teachers' College.

APPLIED SCIENCE

Graduates/Year (steady state): 40

Facilities: New building. Reasonably good equipment. Excellent space. Good head technician.

Curriculum: 4 divisions: Polymer, Food Science, Electronics, Mineral Science.

Employment: 76% of graduates take jobs in industry.

PHYSICS

Graduates/Year: 60-70

Faculty: 30 of lecturer rank and above. Almost all hold Ph.D.'s from foreign universities. Faculty predominantly young and inexperienced but enthusiastic.

Facilities: Excellent laboratory space. Very high caliber equipment, particularly in X-ray diffraction. Additional M$1 million (US $450,000) worth of equipment on order.

Textbooks: Very sophisticated, perhaps too sophisticated for students.

Employment: 80-90% secondary school teaching. Best students judged capable of US graduate work.

CHEMISTRY

Students: Overwhelming majority destined for teaching. Most "major" in 2 subjects: Chemistry/Biology or Chemistry/Physics. Enables them to teach more than one subject in rural schools. Again, best students deemed capable of US graduate work.

Faculty: 39 of lecturer rank or above. As with Physics, nearly all staff members hold Ph.D.'s from foreign universities including Harvard, Chicago, and Berkeley. Staff seems very sophisticated about UK and US chemistry. Have adequate in-house knowledge to select appropriate graduate programs overseas for their best students. Teaching loads very high with obvious implications for faculty research.

Facilities: Excellent space. Very good equipment M$2.6 million (US $1.2 million) in place with an additional M$500,000 (US $230,000) on order.

Texts: Very high quality.

BIOLOGY

Faculty: 41 of lecturer rank and above.

Facilities: Space and equipment excellent. Some reservations as to whether they are fully utilized.

Curriculum: 5 principal divisions: Aquatic Biology, Entomology, Microbiology, Parasitology, Pathology. The Department emphasizes Physiology and Toxicology. It offers 110 courses, including 13 core courses (an unusually high number).

Employment: Most graduates enter secondary school teaching.

PHARMACY

Graduates/Year: 50 (50% female)

Faculty: 13 rank lecturer and above.

Facilities: Again, excellent space and equipment. Students very active in practical labs, despite fact that Department has just moved to new building.

Curriculum: Professional school orientation. Staff well attuned to many of the same issues confronting their counterparts in US and UK, especially interaction of pharmacists with M.D.'s on the prescription of medicines.

Employment: Most students take positions in Government hospitals, in part because of difficulties encountered in establishing private practices.

University's staff, while generally knowledgeable and enthusiastic, appear fairly realistic about their limitations with regard to research. Perhaps largest single research effort is Coastal Resource Baseline studies undertaken by Department of Biological Sciences with financial assistance from Esso Malaysia Bhd. Principal constraints on faculty research quite similar to those at University of Malaya. Most significant disincentive appears to be teaching loads. Facilities are certainly adequate.

See Also: Ministry of Finance, Malaysia. Estimated Expenditures 1979, pp. 399-406. (In Malay).

Universiti Sains Malaysia Handbooks

School of Biological Sciences 1977-78
School of Chemical Sciences 1977-78
School of Physics 1978-79
School of Pharmacy 1978-79

Commonwealth Universities Yearbook 1979

Universiti Pertanian Malaysia (UPM)
(Agricultural University of Malaysia)

Location: Serdang, Selangor--14 miles south of Kuala Lumpur

Vice-Chancellor: Professor Tan Sri Datuk Mohd. Rashdan bin Haji Baba

Elevated to University Status: 1971

Enrollment: 1977--2960

Organizational Structure: 7 faculties, 1 center (Center for Extension and Continuing Education)

Faculties of:
- Agriculture
- Agricultural Engineering
- Educational Services
- Forestry
- Resource Economics and Agribusiness
- Science and Environmental Studies
- Veterinary Medicine and Animal Science

Faculty: (Lecturer rank and above)

Agriculture	76	-- (Home Technology-10
Agricultural Engineering	13	Science & Food
Forestry	17	Technology-11)
Science & Environmental Studies	59	
TOTAL	165	

Large number of faculty hold Ph.D.'s. Many faculty members in Agriculture hold Masters and Ph.D.'s from LSU and other US institutions.

Facilities:

Library: Collection--70,000 volumes, 2600 periodical subscriptions. Capacity--120,000 volumes.

Hostels: Capacity--2413 (1947 men; 466 women).

Campus: 3000 acre campus includes some 300 acres for university buildings, residences and grounds. Remaining 2700 acres constitute University Farm facilities for agricultural field work. UPM--largest unit in Serdang

Agricultural Complex adjacent to Malaysian Agricultural Research and Development Institute (MARDI). University owns another facility at Puchong where studies on crops, trees and poultry are underway.

Branch Campus: Temporarily housed at Natural Resources Training Centre--Semengok, Sarawak, Malaysia. Scheduled for transfer to Bintulu, Sarawak where 2000 acre campus will be developed. Sarawak state government pledged additional concessions of 350,000 acres for timber and plantations to serve as training grounds for agriculture and forestry students. Projected student Population 1986--2000.

Curriculum: UPM recently graduated its first degree students. Total Degree Graduates as of 1/79--300. Agriculture--100. Veterinary Medicine, Economics and Forestry--200. Diploma courses--3 years. MCE minimum admission requirement. Degree courses--5 years. HSC minimum admission requirement. Degree program in Agricultural Engineering requires 32 weeks of work experience. Orientation of entire university very heavily towards applied science.

Employment: Most UPM students hold scholarships and are bonded to serve Government for 7 years. Most will probably work for same agricultural development agencies which have traditionally employed UPM's diploma graduates. These include rubber and land development agencies such as RISDA, FELDA and FELCRA as well as various units of the Ministry of Agriculture. UPM's Faculty of Agricultural Engineering expects bulk of its degree graduates will find employment with Ministry of Agriculture and Drainage and Irrigation Department (DID). Remainder to plantations, palm oil and rubber processing operations and machinery design and sales activities.

Research: While some research has been undertaken, transition to University status and implementation of degree programs has demanded virtually all of faculty's time. In the past, rather small outside grants provided some funding for research. However, 1978-79 first year for which the University had an official research budget. Individual Faculty (Departmental) Research Committees are reviewed by University Research Committee; together, these units decide allocation of research funding.

See Also: Universiti Pertanian Malaysia: Calendar Academic Year 1977-78

Ministry of Finance, Malaysia, 1979 Annual Expenditure, pp. 407-414. (In Malay).

Commonwealth Universities Yearbook, 1979

Universiti Teknologi Malaysia--UTM
(University Technology Malaysia)

Location: Jalan Gurney, Kuala Lumpur 15-02

Vice-Chancellor: Y B Tan Sri Ainuddin bin Abdul Wahid

Elevated to University Status: 1972

Enrollment: 1977--2,900

Faculty:

Built Environment (Construction/Architecture)--7 Lecturer and above; 37 Assistant Lecturers.

Civil Engineering--12 Lecturer and above; 39 Assistant Lecturers
Electrical Engineering--21 Lecturer and above; 26 Assistant Lecturers
Mechanical Engineering--15 Lecturer and above; 33 Assistant Lecturers
Surveying--9 Lecturer and above; 22 Assistant Lecturers
Centre for Science Studies--Chemistry--18 Lecturer and above; 10 Assistant Lecturers
Physics--15 Lecturer and above; 6 Assistant Lecturers

Faculty members with Ph.D.'s are exception rather than rule. Most faculty of Lecturer rank and above hold a variety of Masters degrees and certificates from well known foreign institutions. Exception--Centre for Science Studies, where majority of instructors hold B.Sc. Many faculty members of Assistant Lecturer rank trained at Indonesian institutions: primarily Institute of Technology Bandung, some from Gadja Mada. Extensive use made of Assistant Lecturers, although many are currently away on study leave. Assistant Lecturer ranks also contain several recent Degree graduates from Universiti Kebangsaan and Diploma graduates from UTM.

Facilities:

Hostels: University housing for about 1,700 students (1,100 on campus.)

Library: Open stack library appears up to date and fully adequate for undergraduate education. Collection--80,500 volumes and 3,500 periodicals.

Laboratories: Designed for routine course work. Some lab facilities still under construction.

Curriculum: Both diploma and degree courses offered. HSC not required for admission to UTM degree programs; only MCE necessary. In several departments, diploma and degree candidates take same course of study for three years. Then portion of class is selected on basis of merit to continue for two years. Those not selected are awarded diplomas; those selected are awarded degrees after 5 years. Bachelor of Architecture (Faculty of Built Environment) awarded after 6 years. Built Environment offers degree and diploma courses in Quantity Surveying (Materials Science combined with Business) and Urban and Regional Planning. Mechanical Engineering offers degrees and diplomas in Petroleum Engineering.

Employment: 80% of graduates enter Government service, especially Public Works Department.

Other Information: University's enrollment 90-100% Malay. It does not attract nation's best students. The University administration anticipates that campus will move to Johore Bahru near Singapore in 1983, a move which The Third Malaysia Plan (1976-1980) scheduled for completion in 1982 (p. 394).

See Also: Universiti Teknologi Malaysia Calendar 1977-78

UTM: In Brief.

Commonwealth Universities Yearbook 1979

Universiti Kebangsaan Malaysia
(The National University of Malaysia)

Location: Main campus--Bangi, about 20 miles south of Kuala Lumpur. Science faculties temporarily at Pantai-Kuala Lumpur campus.

Vice-Chancellor: Y B Tan Sri Dr. Anuwar bin Mahmud

Founded: 1970

Enrollment: 1977--3860

Faculty: Faculty of Science: 1100. Includes Department of Mathematics and Unit for Statistics and Computers

Total 1978-79--106 rank Lecturer or above

Biological Sciences

Biochemistry	9
Botany	9
Genetics	12
Microbiology	9
Zoology	14
	53

Physical Sciences

Electronics	6
Physics	14
Geology	14
Chemistry	17
Industrial Chemistry	5
Nuclear Science	7
	53

Of 106, 12 absent on study leave 1978-79. Vast majority of staff hold advanced degrees from foreign universities. In contrast with UTM, relatively few staff members hold tutor rank; virtually all those designated "tutor" listed as on study leave 1978-79. Faculty appeared young, enthusiastic and dedicated to profession. Seemed quite hardworking. Universiti Kebangsaan should improve consistently over time.

Facilities:

New Campus: Faculty of Science hopes to complete move to new campus by 1981. Architect's conceptions of Bangi science complex are impressive. New library of 215,000 sq. ft. and 500,000 volume capacity. Bangi campus design provides all students on-campus housing.

Library: Existing library collection of 220,000 bound volumes and 4,600 periodicals. Faculty of Science at Pantai campus served by separate library with 120,000 volume capacity.

Branch Campus: The University also has branch campus in Sabah at Limauan, 17 miles from state capital of Kota Kinabalu.

Curriculum: The Faculty of Science offers 4-year course leading to B.Sc. Honors and 3-year course leading to general B.Sc. As with University of Malaya and Universiti Sains, there are no diploma courses offered in the sciences. However, HSC not an absolute requirement for admission to Universiti Kebangsaan and Selection Boards may take into account special circumstances. English remains a principal medium of instruction, especially in the sciences where virtually all texts are in English. Many lectures delivered in Malay.

Student Scholarship Support: A rough breakdown of sources of scholarship support for students attending University is as follows:

Ministry of Education	50%
Public Services Department	30%
MARA	20%

Ethnic Composition: Malays comprise roughly 80% of students.

Employment: Majority of graduates find employment as secondary school teachers and with Government agencies. Faculty claims that industry uses very few technical graduates.

See Also: Universiti Kebangsaan Malaysia, pamphlet 23 pp.

Universiti Kebangsaan Malaysia: Fakulti Sains, 108 pp.

Commonwealth Universities Yearbook, 1979

MARA Institute of Technology

Location: Shah Alam, a suburb of Kuala Lumpur

Director: Y. B. Datuk Dr. Awang Had Salleh

Founded: 1965-66

Enrollment: Kuala Lumpur Campus--6,700
Branch campuses--1,000
Sabah, Sarawak, Perlis, Trenggannu

Faculty: School of Engineering: 23 Senior Lecturers and above; 61 Lecturers; 6 Assistant Lecturers

School of Applied Sciences: 17 Senior Lecturers and above; 56 Lecturers

School of Architecture, Planning and Surveying: 13 Senior Lecturers and above; 37 Lecturers; 4 Assistant Lecturers

Faculty at or above the Senior Lecturer level hold a wide variety of upper level degrees and certificates from many foreign institutions. While sizeable proportion of those at Lecturer level hold some form of advanced certificate or degree, majority at this rank hold a B.Sc. or a B.Eng. (large number of these from the University of Malaya). Assistant Lecturers by and large hold diplomas; several are recent graduates of the MARA Institute of Technology.

University Facilities:

Hostels: Capacity 6200

Library: Collection--120,000 volumes
Capacity--500,000 volumes; 1200 periodicals

Curriculum: Institute offers two types of diplomas. Standard Diploma course is 3 years in length. Advanced Diploma course requires 4½ years; Institute's staff considers it equivalent to B.Sc. Staff claims curriculum is "job-oriented."

Vast majority of students admitted holding MCE after Form 5; HSC not required. Some students with aptitude for diploma-level study who lack appropriate academic qualifications admitted to special six-month or one-year Pre-Diploma courses. Upon successful completion of these courses, they are admitted to Diploma courses.

Engineering largest school within Institute. Admission to the engineering program is very competitive according to faculty; only 1 of every 6 applicants accepted.

As elsewhere, while Malay widely used in lecture, nearly all texts are in English.

The Science schools offer diplomas in following fields:

Engineering--Mechanical; Electrical-(Power), (Electronics); Civil; Land Surveying

Applied Sciences--Science; Rubber and Plastics Technology; Textile Technology; Industrial Chemistry; Food Technology; Microbiology; Animal Health and Production; Forestry

Architecture, Planning, and Surveying--Pre-Architecture/Building; Quantity Surveying; Architecture/Interior Design; Building; Town and Regional Planning; Estate Management

Employment: Very large number of graduates find employment with Government. Some businesses find some graduates well-suited to particular needs. However, industry feels Institute's graduates have limited technical background. Many aspire to better-paid administrative and managerial positions. Relatively few remain employed as practicing technicians for extended periods of time.

See Also: MARA Institute of Technology: Prospectus 1977-78 331 pp.

School of Engineering, MARA Institute of Technology: Student Handbook Academic Year 1978/79, 80 pp.

Ungku Omar Politeknik (Polythenic)

Location: Dairy Road, Ipoh, Perak

Principal: Mohd. Nawawi bin Mohd. Zain

Established: 1969

Enrollment: About 1500 students. 20% female. Students must hold an MCE-SPM with a pass (preferably a credit) in Mathematics and a pass in one General or Physical Science subject. Most students on Government scholarship or sponsored by private businesses.

Faculty: 1979 Total--About 100

As of January 1, 1977, 79 Malaysian teaching staff: 15-Civil Engineering; 24-Electrical Engineering; 27-Mechanical Engineering; 13-Commerce

20 Expatriate Staff: 5 Colombo Plan Japanese advisers in Marine Engineering. 15 Peace Corps, Colombo Plan, Japanese and unaffiliated volunteers

Almost all Malaysian staff were: (1) Engineering B.E. and B.Sc. graduates from Commonwealth universities (several with Honors degrees); (2) Diploma graduates from Malaysian universities, especially UTM; (3) Graduates of Technical Teachers' Training College in Kuala Lumpur.

Some staff also hold M.Sc.'s. All foreign staff have university degrees.

Facilities:

Housing: 8 four-story blocks of residences, 2 reserved for women, provide housing for most but not all students. Remainder board in town with relatives or rent rooms.

Library: 15,000 volumes. Regular recipient of 125 periodicals.

Physical Plant: New complex of hostels and buildings housing classrooms and laboratories. Excellent space. Pleasant surroundings.

Laboratories and Workshops: Equipment appears quite good and nearly all facilities seem fully utilized. Activities in mechanical engineering appear better developed than those in civil and electrical. Considerable equipment donated by the Japanese for Marine Engineering program.

Curriculum: Medium of instruction: English--both lecture and materials. Texts and translations not available in Malay.

Length of course: 2 year, 3 months. 9 months coursework, 6 months work experience, 9 months coursework. Sponsored students usually return to work for their sponsor during the 6 month period. Small Marine Engineering course lasts 5 years.

Content: 16 courses of study in 4 departments. (See Faculty above). Time more or less equally divided between classroom and lab/workshop activities. Technical competence of graduates limited. Staff foresees most of the graduates as taking supervisory and managerial positions as opposed to working as trained technicians, a philosophy seemingly quite similar to that of MARA Institute of Technology.

Employment: Holders of Politeknik Certificate in engineering fields qualify for Government appointments designated Technician--salary M$395/month in 1977. Most sponsored students return to work for their sponsors. Students seeking employment with private sector firms have good success.

Employer Satisfaction: Politeknik graduates are usually characterized as having solid grasp on basics. They normally require additional training if they are to be employed as practicing technicians.

See Also: Handbook 1977: Politeknik Ungku Omar.

Kuantan Politeknik

Location: Alor Akar, Kuantan, Pahang

Principal: Mohd. Mokhtar bin Harun

Established: 1976. First class of 70 students graduated January 1979

Enrollment: About 250 students

Faculty: 27-Malaysian teaching staff; 1-Japanese instructor. 8-Civil Engineering; 9-Electrical Engineering; 9-Mechanical Engineering. Faculty Training: 1-M.Sc.; 6-B.Sc.; 12-Diplomas (8 from UTM) and 9 certificates (Sijil Pert.) from MPTKL.

Facilities: Currently housed in part of Kuantan Technical Institute, one of Ministry of Education's vocational high schools. As result, workshops quite small and poorly equipped. Politeknik scheduled to move to new campus on 185 acre site at Semambu in 1981. Polytechnic's new facilities will be modeled after those of its Ipoh counterpart.

Curriculum: 27 month course of study follows same format as Ipoh school. Four courses currently offered include Mechanical Engineering (General), Civil Engineering (Construction) and two in Electrical Engineering, (Power) and (Electronics and Communications). Course offerings will be expanded upon completion of the move to new campus. Class time split about equally between theory and practice; students spend about 50 percent of their time in laboratories and workshops.

Employment: Following quotation outlines the official mandate of the polytechnics:

> "The Kuantan Polytechnic was established by the Ministry of Education in 1976 as a tertiary technical institution to train qualified technicians in the fields of Engineering and Commerce....This group covers many jobs and bears position titles such as: technician, supervisor, foreman, clerk of works, section officer, etc; responsible for applying technology to operation in production and construction, installing and running engineering plant, drafting and designing products, testing and development, estimating cost and so on. It is also responsible for a host of other semi-professional functions under the general supervision of professional engineer or scientist." (p. 1 of the handbook)

Se Also: Politeknik Kuantan: Handbook 1978/79, 34 pp.

Industrial Training Institute (ITI)--
Ministry of Labour and Manpower

Location: Jalan Kucai Lama, Kuala Lumpur

Principal: Rosti bin Saruwono

Faculty: Formerly attempted to recruit instructors from private industry who had at least 5 years job experience in the trade. Now, minimum requirements are MCE and some relevant job experience or secondary-level vocational training. Some instructors recruited from Ministry of Education's vocational schools. Instructors recruited from industry complete a 1-year teacher training course. Instructors without industrial experience complete a 2-Year "sandwich" course with significant formal training, on-the-job training and teacher training components. Instructors completing these in-house, ITI instructor courses are bonded for a period of 5 years.

Facilities:

Hostels: 50% residential, 50% commuter. ITI construction was component of World Bank Education project.

Workshops: Appear adequate. Some aging equipment scheduled to be replaced as part of another World Bank Education project. Recently acquired some very modern printing/photocopying equipment.

Curriculum: 5 major programs.

1) Apprenticeship Training: 90% of students enrolled sponsored by industry. 4-year sandwich course. Year 1--22 weeks of training at ITI. Year 2-4--11 weeks annually. Apprentices are paid their salaries while attending course. They spend remainder of year on the job with their sponsor. Graduates/Year--170.

2) Preparatory Trade Course: Minimum Academic requirements--school attendance through Form 3 (Grade 9), though not necessarily a pass grade on LCE (Lower School Certificate which, like MCE and HSC, is awarded on basis of nationwide exams). Oriented towards school leavers. 1 year training course--6 months formal training, 6 months on-the-job training. Many PTC participants accept full-time positions with firms who provide their on-the-job training after completion of course. 1977 graduates--170.

3) Veterans Re-Training Program: Special courses of 6 months to 1 year for veterans of armed forces. 1977--237 participants.

4) Vocational School Instructor Training Program: 7000-8000 applicants for 150 teaching positions. Those without industrial experience enter the 2-year "sandwich course" described above. Year 1--9 months formal training, 3 months on-the-job training. Year 2--6 months formal training, 6 months teacher training. Principal current activity--gearing up to provide faculty for three new ITIs to be constructed with World Bank loan support: (1) Labuan, Sabah; (2) Kuala Trenggannu; (3) Jchore Bahru. They are tentatively scheduled to open during 1981.

5) Special Short-Term Training Courses: Duration--2-4 weeks. Usually arranged with individual industries on an ad hoc basis. Frequently held at night.

General Notes on Curriculum: Apprenticeship, Preparatory Trade Courses restricted to ages 15-26. ITI training courses devote about 75% of time to practical workshop training and 25% to theory. While attempts are being made to convert to Malay language, most technical terms in English which remains principal medium of lecture instruction. Institute offers course work in 23 trades concentrated in 4 main subject areas: Engineering, Electrical, Construction and Printing.

NITTCB (National Industrial Trade Training and Certification Board) supervises ITI examinations and issues certificates to graduates. Board composed of representatives from Government, industry and labor unions. ITI curriculum attempts to respond to industry needs. High standards enforced; failure of single final exam component means failure of entire exam. Typically, about 40% of course grades based on regularly scheduled performance evaluations completed every 5 weeks. Remaining 60% based on final certificate examination.

Employment: Employment of sponsored apprentices not a problem. About 70% of graduates find immediate employment.

Major Problems: Lack of suitable employment opportunities for those graduates who desire to return to rural areas. Some certificate holders too choosy and ask for salaries that are too high.

Major Employers of Graduates: Private industry such as Volvo, Borneo Motors, F&N (soft-drink and food processing firm). Also National Electric Board and Mines Department in public sector.

Employer Satisfaction: Industrial Training Institutes widely regarded as providing best Government-sponsored vocational training. Industry particularly pleased with Apprenticeship Program.

See Also: A Ministry of Labour and Manpower pamphlet, Training for Industry.

Telecommunications Training Institute
(Operated by the Telecommunications Department--
Ministry of Energy, Telecommunications and Posts)

Location: Off Jalan Gurney, Kuala Lumpur

Faculty: Over 100 teaching staff. 15 hold engineering degrees. Some staff graduated from UTM.

Facilities:

Hostels: Housing for 350 trainees. Usually 200-300 trainees in residence; remainder commute.

Library: Small reference library. Virtually all materials in English.

Physical Plant: Well-maintained building complex. Excellent classroom, workshop and staff office space. Equipment identical to that operated by department in the field. School built with UNDP assistance during early 1960s.

Curriculum: Principal Course: Standard 2-year introductory technician training course. Program composed of a sequence of 8-week courses.

In-Service Courses: 250 courses of 1-4 weeks duration.

Nine departments: (1) Line Planning; (2) Subscriber Operators; (3) Switching; (4) Transmission; (5) Radio; (6) Telegraph; (7) Traffic; (8) General--2-year course; and (9) Management.

2/3 of coursework workshop training, 1/3 theoretical. Heavy emphasis on equipment maintenance. Training provided for workmen involved in placement of poles and lines.

Total Enrollment: 1977 (excludes 2-year course): 19,000 Trainee Weeks 305 courses, 5000 Trainees. (Note: Duplication of course offerings and trainees).

Employment: Almost all trainees remain with Telecommunications Department which dominates nation's communications network. Some trainees later move on to other jobs in private sector.

Starting Salaries: Technician--M$300/month; Technician-Special Grade--M$500/month; Technical Assistant (Have diploma from ITM, UTM)--M$800/month.

Employer Satisfaction: Institute receives very substantial Government support. Department reportedly very pleased with caliber of training offered and performance of "graduates."

See Also: Mimeographed listing of the Institute's courses.

Telecommunications Training Centre, 48 pp., An old departmental pamphlet.

Rubber Research Institute

Location: Main Experiment Station--Sungei Buloh, Selangor, about 25 kilometers from Kuala Lumpur

Director: Dr. Ani bin Arope

Organization: (See attached Organization Chart). 13 Divisions and 2 experiment stations under 3 sections

Staff: 220 technical staff. 38 Ph.D.'s. Nearly all of remainder hold M.Sc. Staff has traveled extensively abroad and most have done degree work overseas. Constant stream of foreign visitors and conference participants provide regular contact with scientific world. Staff encouraged to publish research results. Approximately 8% of staff leave for private sector annually. Senior staff salary--M$36,000 US $16,364 (vs. industry salaries of M$50,000 and up US $22,727).

Budget: M$28 million (US $12.7 million), with M$18 million (US $8.2 million) for salaries.

Facilities: Excellent. 2 major experimental stations. Sungei Buloh (main experiment station) sits on beautiful site which includes 1255 hectare rubber plantations. Most research divisions housed there.

Kota Tinggi station, Johore--an amalgamation of two former estates totaling 1170 hectares. Serves as venue for additional research activities which include innovative socioeconomic study of smallholder production.

Administrative offices and some laboratories in Kuala Lumpur.

Equipment used by Institute is of consistently high caliber. Total value of facilities easily exceeds US $100 million. Has branch laboratory in London.

Library and Information Services: 700,000 books and periodicals in collection. Regular recipient of 700 periodicals from more than 40 countries. Smallholder Project Research Division and Advisory Services Division responsible for dissemination of research results through coordinated effort with extension and land development agencies such as RISDA, FELDA and FELCRA. Advisory Services Division also sponsors conferences at which Malaysian planters and researchers present findings and discuss recent research developments.

Scope of Activities: Integrated approach to research for all aspects of production of rubber from soil science, plant science and plant pathology through harvesting, processing and manufacturing of natural rubber products.

Technical Services: (1) Analytical Chemistry Division: Provides complete set of analytical services for Malaysian natural rubber industry. Includes soil, plant, latex, effluent and other important analyses. Has performed as many as 30,000 routine analyses in one month.

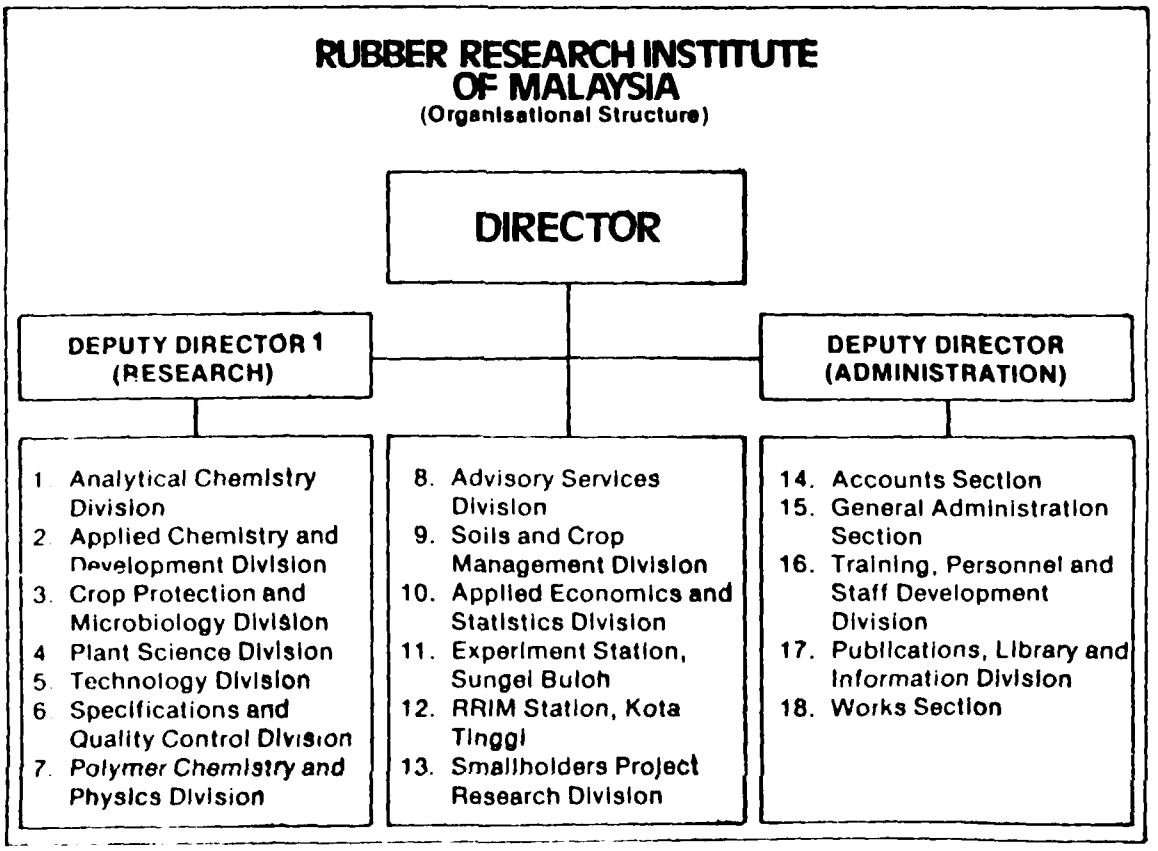
(2) Specifications and Quality Control Division: Establishes and monitors standards and grading scheme for SMR (Standard Malaysian Rubber). Standards enforced at 30 approved SMR laboratores around the country. Total SMR production topped 500,000 tons/year (as compared with a total production of 1.64 million tons in 1978).

Non-profit, self-supporting Commercial Testing Unit charges fees for testing and certification of SMR done for producers without their own laboratories.

(3) Applied Economics and Statistics Division: Completes production cost and management studies for estates. Also registers clones and planting materials.

Assessment: Technical services--very strong. Biological and harvesting technology--strong. Polymer chemistry--does not approach state of the art in developed nations. Rubber products--few products or processes developed and subsequently adopted by industry. Even RRI suffers from staffing problems, especially departure of talented researchers. Staff very knowledgeable about science outside Malaysia. Accustomed to dealing with foreign visitors. Excellent briefing format and public relations presentations.

See Also: Official Institute pamphlet entitled Rubber Research Institute of Malaysia. May 1978.


RUBBER RESEARCH INSTITUTE OF MALAYSIA
(Organisational Structure)
DIRECTOR
DEPUTY DIRECTOR 1 (RESEARCH)
DEPUTY DIRECTOR (ADMINISTRATION)
1. Analytical Chemistry Division
2. Applied Chemistry and Development Division
3. Crop Protection and Microbiology Division
4. Plant Science Division
5. Technology Division
6. Specifications and Quality Control Division
7. Polymer Chemistry and Physics Division
8. Advisory Services Division
9. Soils and Crop Management Division
10. Applied Economics and Statistics Division
11. Experiment Station, Sungei Buloh
12. RRIM Station, Kota Tinggi
13. Smallholders Project Research Division
14. Accounts Section
15. General Administration Section
16. Training, Personnel and Staff Development Division
17. Publications, Library and Information Division
18. Works Section

Technology Center of RRI
(Organization Chart Attached)

Location: Sungei Buloh, part of the main RRI experiment station

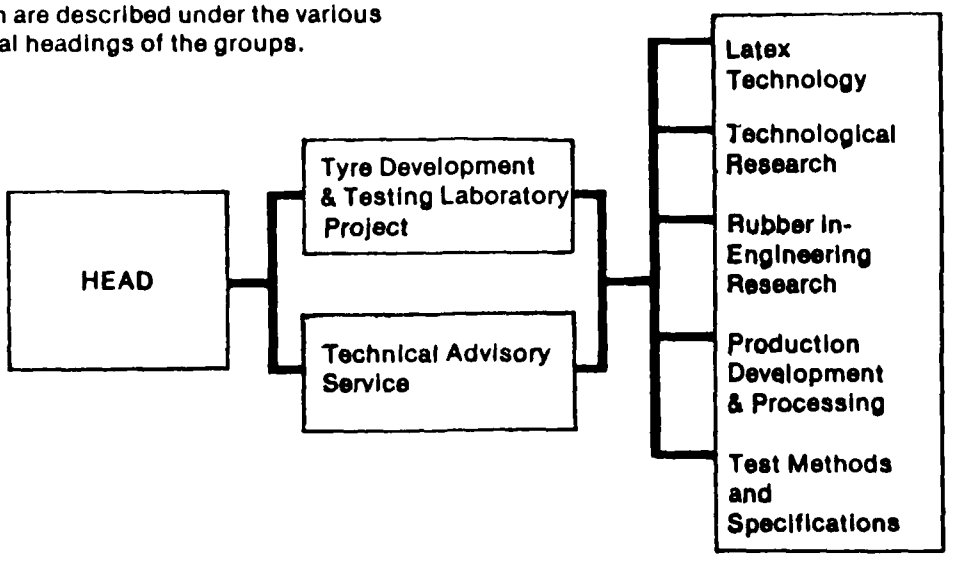
Facilities: M$20 million (US $9.1 million) in buildings and equipment including M$5 million (US $2.3 million) worth of commercial processing and manufacturing equipment donated by Japanese Government. Testing facilities and microscopy equipment (including several electron microscopes) for latex research are impressive. While equipment and facilities are excellent, some question as to how fully hardware is utilized.

Scope of Activities: Emphasis on uses for Malaysian rubber which will help increase the value added component of rubber exports. Manufacture and testing of natural rubber tires; biochemistry of latex; processing of rubber; manufacturing of various rubber products.

ORGANISATIONAL STRUCTURE

The staff and facilities at the Technology Centre have been grouped in the following organsational structure to effectively carry out the various research and development programmes of the Division.

Some of the projects and activities of the Division are described under the various sectional headings of the groups.



Forest Research Institute

Location: Kepong, Selangor--about 10 miles West of Kuala Lumpur

Director: Salleh bin Mohammed

Staff: 48 professional staff posts--19 vacant. 3 Ph.D.'s, 7 Masters, many young professionals. Up to 1/3 of Institute's staff moves on each year to take positions in private sector. Rapid turnover of directors.

Budget: Operating Budget 1979: M$2.8 million (US $1.3 million). Annual increase limited to 10%.
Capital Budget 1979: M$2 million (US $900,000) for development of Institute's facilities.

Facilities:

- Library: 12,000 bound volumes including texts and 60,000 pamphlets, reports and reprints.
- Herbarium: 100,000+ specimens of Malaysian plants, especially trees.
- Wood Collection: 10,000+ samples of local timbers.
- Arboretum: Living collection of hundreds of tree species from all of Malaysia.
- Nursery: Capable of raising 500,000 seedlings/year for research purposes.
- Laboratories/ Workshops: Limited lab facilities. A number of kilns for charcoaling experiments. New chemistry building under construction in January 1979.

Publications: Journal, The Malaysian Forester, worldwide distribution. Also produces variety of other useful reports for more limited distribution.

Scope of Activities:

- Technical Services: (1) Technical advisory services to manufacturers and sawmills; (2) Testing for private companies without facilities; (3) Testing of wood quality for potential customers.
- Forest Management: Malaysia has over 2000 tree species; only 60 are currently used for timber products. Institute's expertise is in lowland

forests; rarely deals with hill forests despite fact that it also has jurisdiction over research on watershed management problems. Staff interested in agri-forestry, including pine plantations (of which 150,000 acres already exist in Malaysia). Also has done work which seeks to intersperse food crops between stands of young trees.

Institute's major concern--extremely rapid rate at which Malaysia's forests are being cut--circa 1 million acres/year. Estimate only 17.6 million acres of usable forests remain. As yet, no serious attempts at hardwood reforestation.

Forests Products Research: About 600 of 2,000 species are being examined with regard to potential uses. Particular concern--investigation of uses for rubber wood.

See Also: 1978 brochure, Forest Research Institute, published by the Institute.

Mines Research Institute

Location: Jalan Harimau (Tiger Lane), Ipoh, Perak (adjacent to the Geological Survey Lab)

Director: Dr. H. Hussin

Staff: 15 professional staff. 9 engineers, 6 research officers. (At least 15 additional positions currently vacant). Institute has considerable difficulty attracting qualified staff. It also regularly loses staff to more lucrative positions in private sector.

Facilities: Laboratories and equipment quite old and appear to be designed primarily for routine sample analysis. The Institute owns and operates a number of drilling rigs for core samples.

Southeast Asia Tin Centre under construction on an adjacent site. Centre jointly sponsored by Malaysia, Indonesia and Thailand. UNDP reportedly committed to providing some technical advisers to the Centre.

Publications: In previous years, Institute produced some brief assessments of its activities in stapled, mimeographed form for limited distribution.

Scope of Activities: 90% or more of Institute's activities are directed towards tin. Institute primarily seeks to assist some 600 smaller mines as larger companies have little need of technical assistance. About 50% of work facility does related to mine safety. Remaining 50% devoted primarily to routine testing and analysis. Most notable research activity has dealt with introduction of new processes for enhanced physical recovery of tin from low-grade alluvial cassiterite ores. Techniques utilized include froth flotation and hydrometallurgy. Little interaction with adjacent Geological Survey Lab.

See Also: The Mines Research Institute, November 1977. 8 pp.

Standards and Industrial Research Institute of Malaysia (SIRIM)

Location: Kuala Lumpur

Controller: Mr. Abdullah bin Mohd. Yusof

Staff: 105 professionals. 450 supporting staff

Budget: Operating Budget 1979: M$7.3 million (US $3.3 million). Increasing at about 10% per annum. Capital Budget 1979: M$2.2 million (US $1 million). vs. M$1.05 million (US $480,000) for 1978. Constitutes special allowance for building and equipment.

Facilities: Testing equipment and laboratories reasonably modern and in good condition.

Scope of Activities: (1) Standardization and Standards Development; (2) Testing, Certification Marking and Other Quality Assurance Activities; (3) Calibration and Metrology Services; (4) Industrial Research; (5) Industrial Extension and Consultancy; (6) Technical Information Services; and (7) Assistance in Conversion to the Metric System.

Technical Services: Preceding range of services provided to private businesses and other Government agencies free of charge or for nominal fees. Precision calibration services available. SIRIM's Library and Information Service has access to Malaysian, regional and international data banks of technical information services, including IDRC in Canada and facilities in the UK.

Research and Development: Focuses on processes and products for small industries, particularly those utilizing domestic raw materials and waste products. Also some work on alternative energy sources. Examples: Non-fired laterite bricks, rice hulls in cement, uses for rubber wood, electronics products, pollution problems (palm oil effluent). Foundries for metal-working and plastics for small industry. Rubber products, metals, ceramics. Biogas technology, solar-powered rice dryers, rice hull burners. These R&D efforts have produced few commercially successful products or processes.

Assessment: SIRIM appears to be doing commendable job of providing a range of very necessary, routine technical services, particularly testing. Research, development and industrial extension activity less impressive. Unclear (1) to what degree research efforts are subject to criterion of commercial feasibility and (2) how actively SIRIM attempts to promote and disseminate its research results.

See Also: Ministry of Finance, Malaysia, 1979 Estimated Expenditures, pp. 617-627. (In Malay).

SIRIM--A Factural Broadsheet, 1979. 10 pp.

SIRIM. 40 pp. Brochure on operations of the Institute.

Chemistry Department

Location: Jalan Sultan, Petaling Jaya--a suburb of Kuala Lumpur

Director-General: Dr. R. D. Amarasingham

Staff: About 100 professionals: Mainly chemists with sprinkling of engineers and an occasional zoologist. Most hold honors degrees and many received graduate level training abroad.

Total Headquarters Staff--About 300. An additional 200 employees stationed at regional laboratories around the country.

Budget: Operating Budget: M$5,000,000/year (US $2,3 million). Increasing at an annual rate of 20%.
Capital Budget: Supplemental allocation totaling about 5-10% of operating budget figure used for purchases of equipment. Special funding of major facilities expansion effort.

Facilities: Very crowded. Large number of adequately equipped labs designed to handle routine, "wet chemistry" testing. Construction of new buildings at Petaling Jaya headquarters (monies already appropriated) will roughly double the Department's largest facility.

Scope of Activities: Forensic chemistry, food, water quality, customs work, some product testing. 220,000 samples/year. Appeared to be performing a very necessary job quite competently.

See Also: Report of the Chemistry Department for the Year 1976

Geological Survey Laboratory

Location: Jalan Harimau, Ipoh, Perak
(adjacent to the Mines Research Institute)

Director: Dr. Jaafar

Staff: 37 professional staff. 12 chemists and 25 geologists. Most have received some training abroad, particularly for Masters and Ph.D. Staff members regularly seconded to state offices of the Geological Survey.

Budget: Circa M$5 million (US $2.3 million). Lab collects M$500,000 (US $230,000) in fees from private sector and other Government agencies for testing performed.

Facilities: A number of busy,well-run labs for routine analyses. Initiative of lab administrators enabled facility to obtain several pieces of high-quality equipment, some from CIDA (Canada's AID) and Swiss and Swedish governments.

Publications: Produces hardcover reports for international distribution (300 recipients worldwide). Lack of technical English editor has swollen backlog of reports to 40.

Scope of Activities:

Departments: (1) Hydrology; (2) Mapping; (3) Engineering Construction; (4) Building Materials; (5) Rock Dating.

Community Service: Drills wells which supply rural communities with sources of drinking water.

Technical Services: (1) Routine testing for Police, Customs and Industry. M$50/sample for analyses done for private sector; (2) Maintains catalogues which denote location of sources of building materials and existing mining claims; (3) Develops resource maps for country which highlight probable locations of tin and base metal deposits; and (4) Maintains substantial library of reference materials and complete collection of its own reports.

Rock Dating: Regional rock dating center to be established and housed at this facility. Will utilize atomic absorption equipment donated by Swiss government.

International Cooperation: Canadian advisers in residence. LANDSAT imagery (1) discovered a major fault; (2) delineated mangrove swamps which may correlate with geological features.

Assessment: Considerable potential for significant contributions to Malaysia's development. Involved in several important activities.

Motorola Research Lab

Location: Bayan Lepas Free Trade Zone, Penang

Manager: Bruce Stone

Staff: 28 people including 13 professionals; 1 Malay, the balance Chinese. Employs only engineers and does not anticipate hiring any science graduates. Staff hardworking and considered reliable.

Salaries: Engineers--M$1300/month (US $591)
Total Benefits--M$2000/month (US $909)
Top Salary--M$3000/month (US $1364)

Scope of Activities: Unit specializes in hardware design, primarily "breadboard designs"(layouts, circuits) for specialty applications in communications products. Considerable innovation is required, particularly for special order equipment. Design work not limited to drawing board. Frequently, staff tests prototypes it develops. Lab is in direct competition with similar Motorola facility in Fort Lauderdale, Florida.

APPENDIX B

Suggested Readings

(Supplement to those sources noted in Appendix A)

Country Setting--Political

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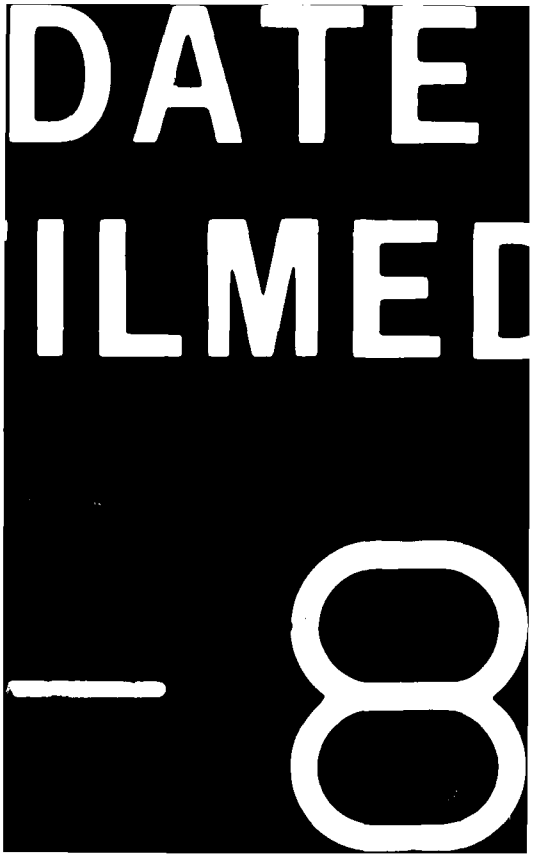
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